REPORT

OF THE

FOURTH MEETING

OF THE

Australasian Association for the Advancement of Science,

HELD AT

HOBART, TASMANIA, IN JANUARY, 1892.

EDITED BY A. MORTON, F.L.S.

Published by the Association.

PERMANENT OFFICE OF THE ASSOCIATION,

THE ROYAL SOCIETY'S HOUSE, 5, ELIZABETH-STREET, SYDNEY.

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TASMANIA:

WILLIAM GRAHAME, JUN.,
ACTING GOVERNMENT PRINTER, HOBART.
1893.

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Section B.

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OBJECTS AND RULES OF THE ASSOCIATION.

Carried at the Christchurch Meeting in January, 1891; submitted and confirmed at the Hobart Meeting, January, 1892.

OBJECTS OF THE ASSOCIATION.

The objects of the Association are to give a stronger impulse and a more systematic direction to scientific enquiry; to promote the intercourse of those who cultivate science in different parts of the Australasian Colonies and in other countries; to obtain more general attention to the objects of science, and a removal of any disadvantages of a public kind which may impede its progress.

RULES OF THE ASSOCIATION.

Members and Associates.

1. Members shall be elected by the Council; the annual subscription shall be £1, but after June 30th, 1895, Members will be required to pay an entrance fee of £1 in addition.

2. The annual subscription shall be £1, due on the 1st July in each year.

3. A member may at any time become a Life Member by one payment of £10, in lieu of future annual subscriptions.

4. Members who fail to pay their subscription before the Annual Session of the Association cease to be members, but may rejoin by paying the entrance-fee in addition to the annual subscription.

5. The Local Committee may admit any person as an Associate for the year on the payment of £1.

6. Associates are eligible to serve on the Local Reception Committee, but are not eligible to hold any other office, and they are not entitled to receive gratuitously the publications of the Association.

7. Ladies' tickets (admitting the holders to the General and Sectional Meetings, as well as the Evening Entertainments) may be obtained by full Members on payment of 5*s.* for each ticket. Ladies may also become either Members or Associates on the same terms as gentlemen.

Sessions.

8. The Association shall meet in Session periodically for one week or longer. The place of meeting shall be appointed by the Council two years in advance, and the arrangements for it shall be entrusted to the Local Committee.

MANAGEMENT OF THE AFFAIRS OF THE ASSOCIATION.

Council.

9. There shall be a Council consisting of the following:—(1) Present and former Presidents, Vice-Presidents, Treasurers, and Secretaries of the Association, and present and former Presidents, Vice-Presidents, and

Secretaries of the Sections. (2) Authors of Reports or of Papers published *in extenso* in the Annual Reports of the Association.

10. The Council shall meet only during the Annual Meeting of the Association, and during that period shall be called together at least twice.

Local Committees.

11. In the intervals between the Sessions of the Association its affairs shall be managed in the various colonies by Local Committees. The Local Committee of each colony shall consist of the Members of Council resident in that Colony.

Officers.

12. The President, five Vice-Presidents (elected from amongst former Presidents), a General Treasurer, one or more General Secretaries and Local Secretaries shall be appointed annually by the Council.

13. The Governor of the colony in which the Session is held shall be *ex officio* a Vice-President.

Reception Committee.

14. The Local Committee of the colony in which the Session is to be held shall form a Reception Committee to assist in making arrangements for the reception and entertainment of the visitors. This Committee shall have power to add to its number.

Office.

15. The permanent office of the Association shall be in Sydney.

Money Affairs of the Association.

16. The financial year shall end on the 30th June.

17. All sums received for life subscriptions and for entrance fees shall be invested in the names of three Trustees appointed by the Council, and the interest only arising from such investment shall be applied to the uses of the Association.

18. The subscriptions shall be collected by the Local Secretary in each colony, and by him forwarded to the General Treasurer.

19. The Local Committees shall not have power to expend money without the authority of the Council, with the exception of the Local Committee of the Colony in which the next ensuing Session is to be held, which shall have power to expend money collected or otherwise obtained in that colony. Such disbursements shall be audited, and the Balance-sheet and the surplus funds forwarded to the General Treasurer.

20. All cheques shall be signed either by the General Treasurer and the General Secretary, or by the Local Treasurer and the Secretary of the colony in which the ensuing Session is to be held.

21. Whenever the balance in the hands of the Banker shall exceed the sum requisite for the probable or current expenses of the Association, the Council shall invest the excess in the names of the Trustees.

22. The whole of the accounts of the Association, *i.e.*, the local as well as the general accounts, shall be audited annually by two Auditors appointed by the Council; and the Balance-sheet shall be submitted to the Council at its first meeting thereafter.

Money Grants.

23. Committees and individuals to whom grants of money have been entrusted are required to present to the following meeting a report of the progress which has been made, together with a statement of the sums which have been expended. Any balance shall be returned to the General Treasurer.

24. In each Committee the Secretary is the only person entitled to call on the Treasurer for such portions of the sums granted as may from time to time be required.

25. In grants of money to Committees, or to individuals, the Association does not contemplate the payment of personal expenses to the members or to the individual.

Sections of the Association.

26. The following Sections shall be constituted :—

A.—Astronomy, Mathematics, and Physics.
B.—Chemistry.
C.—Geology and Mineralogy.
D.—Biology.
E.—Geography.
F.—Ethnology and Anthropology.
G.—Economic Science and Agriculture.
H.—Engineering and Architecture.
I.—Sanitary Science and Hygiene.
J.—Mental Science and Education.

Sectional Committees.

27. The Presidents, Vice-Presidents, and Secretaries of the several Sections shall be nominated by the Local Committee of the Colony in which the next ensuing Session of the Association is to be held, and shall have power to act until their election is confirmed by the Council. From the time of their nomination, which shall take place as soon as possible after the Session of the Association, they shall be regarded as an Organising Committee, for the purpose of obtaining information upon papers likely to be submitted to the Sections, and for the general furtherance of the work of the Sectional Committees. The Sectional Presidents of former years shall be *ex officio* Members of the Organising Committees.

28. The Sectional Committees shall have power to add to their number.

29. The Committees for the several Sections shall determine the acceptance of papers before the beginning of the Session. It is therefore desirable, in order to give an opportunity to the Committees of doing justice to the several communications, that each author should prepare an abstract of his paper, of a length suitable for insertion in the published Transactions of the Association, and that he should send it, together with the original paper, to the Secretary of the Section before which it is to be read, so that it may reach him at least a fortnight before the Session.

30. Members may communicate to the Sections the papers of non-members.

31. The author of any paper is at liberty to reserve his right of property therein.

32. The Sectional Committees shall meet at 2 P.M. on the first day of the Session in the rooms of their respective Sections, and prepare the Programmes for their Sections and forward the same to the General Secretaries for publication.

33. On the second and following days the Sectional Committees shall meet at 10 A.M.

34. No report, paper, or abstract shall be inserted in the annual volume unless it be handed to the Secretary before the conclusion of the Session.

35. The Sectional Committees shall report to the Publication Committee what papers it is thought advisable to print.

36. They shall also take into consideration any suggestions which may be offered for the advancement of Science.

Research Committees.

37. In recommending the appointment of Research Committees all Members of such Committees shall be named, and one of them, who has notified his willingness to accept the office, shall be appointed to act as Secretary. The number of Members appointed to serve on a Research Committee should be as small as is consistent with its efficient working. Individuals may be recommended to make Reports.

38. All recommendations adopted by Sectional Committees shall be forwarded without delay to the Recommendation Committee; unless this is done the recommendation cannot be considered by the Council.

39. The President of each Section shall take the chair and proceed with the business of the Section at 11 A.M. precisely. In the middle of the day an adjournment for luncheon shall be made; and at 4 P.M. the Sections shall close.

40. At the close of each meeting the Sectional Secretaries shall correct, on a copy of the official journal, the lists of papers which have been read, and add to them those appointed to be read on the next day, and send the same to the General Secretaries for printing.

Recommendation Committee.

41. The Council at its first meeting in each year shall appoint a Committee of Recommendations to receive and consider the Reports of the Research Committees appointed at the last Session, and the recommendations from Sectional Committees. The Recommendation Committee shall also report to the Council, at a subsequent meeting, the measures which they would advise to be adopted for the advancement of Science.

42. All proposals for the appointment of Research Committees and for grants of money must be sent in through the Recommendation Committee.

Publication Committee.

43. The Council shall each year elect a Publication Committee, which shall receive the recommendation of the Sectional Committees with regard to publication of papers, and decide finally upon the matter to be printed in the volume of Transactions.

Alteration of Rules.

44. No alteration of the Rules shall be made unless due notice of all such additions or alterations shall have been given at one Annual Meeting and carried at a subsequent Annual Meeting of the Council.

OFFICERS AND COUNCIL, 1892.

President:

His Excellency Sir Robert G. C. Hamilton, K.C.B., LL.D.

Vice-Presidents:

Professor W. C. Kernot, M.A., C.E., President of the Royal Society of Victoria.
Hon. A. Norton, M.L.C., President of the Royal Society of Queensland.
Rev. Thomas Blackburn, President of the Royal Society of South Australia.
H. C. Russell, B.A., C.M.G., F.R.S., President of the Royal Society of New South Wales.

Hon. General Treasurer:

H. C. Russell, B.A., C.M.G., F.R.S.

Hon. Local Treasurer:

J. B. Walker, Esq., F.R.G.S.

Hon. General Secretaries:

Professor Liversidge, M.A., F.R.S.
A. Morton, F.L.S.

Hon. Secretaries for other Colonies:

A. H. Lucas, M.A., B.S.C., Melbourne.
John Shirley, M.A., B.S.C., Brisbane.
F. Wright, Adelaide.
Professor Parker, B.Sc., F.R.S., C.M.Z.S, } New Zealand.
Professor Thomas, M.A., F.L.S., F.G.S, } New Zealand.
A. de B. Brandon, } New Zealand.

Ordinary Members of Council:

The Council consists of the following :—(1) Present and former Presidents, Vice-Presidents, Treasurers, and Secretaries of the Association, and present and former Presidents, Vice-Presidents, and Secretaries of the Sections. (2) Authors of Reports or of Papers published *in extenso* in the Annual Reports of the Association.

Auditors:

R. Teece, F.I.A. | R. A. Dallen.

Trustees:

H. C. Russell, B.A., F.R.S. | R. L. J. Ellery.
Professor Liversidge, M.A., F.R.S.

Publication Committee:

J. Barnard.	R. M. Johnston, F.L.S
J. B. Walker, F.R.G.S.	F. J. Young, B.A.
Colonel Legge, R.A.	F. M. Young, B.A.
W. F. Ward, A.R.M.S.I.	A. Morton, F.L.S.
A. Montgomery, M.A.	W. W. Eldridge.
A. Mault.	

PRESIDENTS, Vice-Presidents, and Secretaries of the Sections at the Hobart Meeting, January, 1892.

	Presidents.	*Vice-Presidents.*	*Secretaries.*
SECTION A.—ASTRONOMY, MATHEMATICS, PHYSICS, AND MECHANICS.	Professor W. H. Bragg, M.A.	The Archbishop of Hobart. A. B. Biggs.	Capt. Shortt, R.N. W. E. Shoobridge.
SECTION B.—CHEMISTRY AND MINERALOGY	W. M. Hamlet, F.C.S., F.I.C.	W. F. Ward, A.R.S.M. Samuel Clemes.	A. J. Taylor, F.L.S. H. T. Gould.
SECTION C.—GEOLOGY AND PALÆONTOLOGY	Professor T. M. E. David, B.A., F.G.S.	T. Stephens, M.A., F.G.S. A. Montgomery, M.A.	F. Belstead. B. Shaw.
SECTION D.—BIOLOGY	Professor W. Baldwin-Spencer, M.A.	Colonel Legge, R.A. W. F. Petterd, C.M.I.S. Augustus Simson	P. S. Seager. L. Rodway, L.D.S.
SECTION E.—GEOGRAPHY	Commander Pasco, R.N.	E. A. Counsel, F.R.G.S. J. R. M'Clymont, M.A. Rev. J. B. Woollnough, M.A.	F. M. Young, B.A.
SECTION F.—ECONOMIC AND SOCIAL SCIENCE AND STATISTICS.	R. Teece, F.I.A.	Hon. A. I. Clark, M.E.C. Hon. N. J. Brown, M.H.A. A. J. Ogilvy.	R. M. Johnston, F.L.S.
SECTION G.—ANTHROPOLOGY	Rev. Lorimer Fison, M.A.	Rev. George Clarke. James Barnard.	J. B. Walker, F.R.G.S.
SECTION H.—SANITARY SCIENCE AND HYGIENE ...	Professor W. H. Warren, M.I.C.E.	Hon. P. O. Fysh, M.L.C. C. E. Barnard, M.D. E. O. Giblin, M.D.	A. Mault.
SECTION I.—LITERATURE AND FINE ARTS	Professor E. E. Morris, M.A.	Hon. J. W. Agnew, M.D. Rev. Thomas Kelsh. Russell Young.	F. J. Young, B.A.
SECTION J.—ARCHITECTURE AND ENGINEERING ..	C. Napier Bell, C.E.	C. H. Grant, C.E. James Fincham, C.E. F. Kayser. C. W. James, C.E., A.M.I.C.E.	W. W. Eldridge. A. North.

GENERAL PROGRAMME FOR THE MEETING.

THURSDAY, 7TH JANUARY, 1892.

11 A.M.—General Council meets in the Room of the Royal Society.

2 P.M.—Sectional Committees meet in their Rooms.

3 P.M.—Reception by His Excellency Sir R. G. C. Hamilton in the Grounds of Government House.

8 P.M.—Presidential Address in the Reception Room, Town Hall.

FRIDAY, 8TH JANUARY.

10 A.M.—Sectional Committees meet in their Section Rooms. The following Presidential Addresses will be delivered :—

10·30 A.M.—Section A : Professor W. H. Bragg.
Section B : Mr. W. M. Hamlet, F.C.S.
Section C : Professor T. W. E. David, F.G.S.

11·30 A.M.—Section D : Professor W. Baldwin Spencer.
Section E : Commander Pasco, R.N.
Section F : Mr. R. Teece, F.I.A.

2 P.M.—Section G : Rev. Lorimer Fison.
Section H : Professor W. H. Warren.

3 P.M.—Section I : Professor E. E. Morris.
Section J : Mr. C. Napier Bell.

8 P.M.—Lecture by Dr. Giffen.

SATURDAY, 9TH JANUARY.

10 A.M.—Sectional Committees meet.

10·30 A.M.—Sections meet for reading and discussing Papers.

Garden Party at Mr. Henry Dobson's, Huon Road. Coaches will leave the Town Hall at 2 P.M. sharp.

SUNDAY, 10TH JANUARY.

The Rev. Geo. Clarke, Vice-Chancellor of the Tasmanian University, and Vice-President of Section G, will preach the Science Sermon to the Association in the Davey-street Congregational Church, at 11 A.M. Subject, "From Man to Nature, and from Man to God."

The Rev. Dr. Corlette, of New South Wales, will preach a Science Sermon to the Members of the Association in St. David's Cathedral, at 7 P.M. on Sunday, the 10th January.

The Rev. Father Kelsh will preach a Science Sermon to the Members of the Association in St. Joseph's Church, at 7 P.M. on Sunday, 10th January. Subject—"Science and Religion."

MONDAY, 11TH JANUARY.

10 A.M.—Sectional Committees meet.

11 A.M.—Sections meet for reading and discussing Papers.

2 P.M.—Recommendation Committee meets in Secretary's Office. Visit to the Botanical Gardens.

8 P.M.—Lecture in Reception Hall. "The Great Sutherland Waterfalls," by Mr. C. W. Adams. Illustrated by Photographs and Lime-light.

TUESDAY, 12TH JANUARY.

10 A.M.—Sectional Committees meet.

11 A.M.—Sections meet for reading and discussing Papers.

8 P.M.—Musical evening in the Reception Room.

WEDNESDAY, 13TH JANUARY.

10 A.M.—Sectional Committees meet.

10·30 A.M.—Sections meet for reading and discussing Papers.

2 P.M.—Recommendation Committee meets.

3·30 P.M.—Garden Party, given by the Bishop of Tasmania and Mrs. Montgomery, at Bishopscourt.

8 P.M.—Lecture in the Reception Room, "Early Hobart," by Mr. J. B. Walker.

THURSDAY, 14TH JANUARY.

10 A.M.—General Council meets to receive Report of Recommendation Committee, to appoint Officers, and transact general business.

FRIDAY, 15TH JANUARY.

12·30 P.M.—Excursion to New Norfolk and Salmon Ponds. Entertainment by His Worship the Mayor of Hobart and Mrs. Reynolds.

SATURDAY, 16TH JANUARY.

8·30 A.M.—Excursion to Port Arthur (Carnarvon) by s.s. *Flora*.

N.B.—Luncheon is provided daily in a Marquee at the back of the Town Hall, from 1 to 2 P.M.; also, afternoon tea.

MEETING OF THE GENERAL COUNCIL,

Thursday, 7th January, 1892.

Extracts from the Minutes.

Baron Von Mueller, K.C.M.G., Ph.D., F.R.S., in the Chair. About fifty Members were present.

The Minutes of the last Meeting in New Zealand were taken as read and adopted.

Letter was read from Sir James Hector, the retiring President, stating his regret at being unable to attend the meeting through ill-health, regret for which was fully expressed.

The arrangements made for the Hobart meeting were ratified, and a hearty vote of thanks given to Mr. Morton for his untiring exertions thereto.

The following correspondence was read :—

(*a*). From the Permanent Secretary of the American A. A. Society acknowledging receipt of resolution forwarded as to uniformity in Biological Nomenclature.

(*b*). From the Admiralty, stating that the name "Tasman Sea" would be inserted in the Admiralty Chart as desired.

(*c*). From the Crown Lands Department of New Zealand as to the reservation of Little Barrier and Resolution Islands.

(*d*). From Royal Geographical Society of Australasia (Queensland Branch), notifying the appointment of His Excellency Sir H. Norman to represent the Society at the Hobart Meeting.

(*e*). From Institution of Surveyors, N.S.W., nominating Messrs. D. M. Maitland and G. H. Knibbs as representatives to the Hobart Meeting.

(*f*). From Royal Society of South Australia, notifying appointment of Mr. R. W. Chapman to represent the Society at the Hobart Meeting.

(*g*). From Royal Geographical Society of Australasia (Victorian Branch), notifying appointment of Mr. A. O. Sachse as delegate from the Society to the Hobart Meeting.

(*h*). From Royal Geographical Society of Australasia (South Australian Branch), notifying appointment of Hon. D. Murray as delegate from the Society to the Hobart Meeting.

(*i*). From Royal Society of Queensland, notifying appointment of His Excellency Sir Henry Norman, and Messrs. R. Roe, M.A., J. F. Shirley, B.Sc., and F. M. Bailey, as delegates from the Society to the Hobart Meeting.

Professor Liversidge explained that the Balance-sheet would be published in the annual volume, and that the funds were in a flourishing condition.

The election of the Sectional Officers and Committees was approved.

The Recommendation Committee was appointed.

His Excellency Sir H. Norman proposed that the sixth Meeting should be held at Brisbane; seconded by Professor Bragg, supported by Mr. J. Shirley, and carried.

Professor Spencer moved—That the revised Code of Rules of the Association be confirmed; seconded by Mr. C. A. Topp, and carried.

Professor Liversidge moved—That the next Meeting be held at Adelaide in 1893, the fixing of exact date to be left to discretion of Officers and Committee in Adelaide; seconded by Mr. J. Barnard, and carried.

The Officers for the fifth Meeting were appointed.

The Trustees and Auditors of the Association were appointed as follows :—*Trustees*—Messrs. H. C. Russell, R. L. J. Ellery, Professor Liversidge. *Auditors*—Messrs. R. Teece and R. A. Dallen.

Mr. Ross moved—That it be a recommendation to the Council that in future a list of Papers read at the Meetings of the Association should be sent to the Members who paid their subscriptions but who did not attend the meeting; seconded by Mr. A. J. Taylor, and carried.

MEETING OF THE GENERAL COUNCIL,

THURSDAY, 14TH JANUARY, 1892.

Extracts from the Minutes.

His Excellency Sir R. G. C. Hamilton, President, in the Chair. About 50 Members were present. The Minutes were taken as read, and signed by the Chairman.

The proposition for the establishment of a "Tasmanian Flora" (suggested by Capt. Parker) by the Association was discussed, and the following was carried, on the motion of Professor Spencer, "That the Council regretted that it could not see its way to comply with the suggestion."

The following were appointed a Committee on the "Photographing of Geological Surveys"—Mr. E. P. Bishop, Professor Tate, Sir James Hector, Mr. F. Belstead; Mr. J. H. Harvey, Secretary.

The Report of the Recommendation Committee, brought up by Professor Liversidge, was adopted, and ordered to be carried into effect.

The following Committees were appointed :—

Committee (re-appointed) to report upon the composition and properties of the Mineral Water of Australasia. *Members*—Professor Liversidge, Mr. Skey, Mr. G. Gray (Secretary).

Committee for the preparation of a Census of the Minerals of Tasmania and determination of the same. *Members*—S. Clemes, A. J. Taylor, W. F. Ward, H. Gould, A. Montgomery, F. W. Petterd, A. J. Taylor (Secretary).

Committee to report upon the protection of Native Animals. *Members*—Professor Tate, Professor Spencer, Colonel Legge, A. J. Campbell, G. M. Thomson, S. Dixon, A. F. Robin (Secretary).

Committee (re-appointed) for the investigation of Seismological Phenomena in Australasia. *Members*—A. B. Biggs, R. L. J. Ellery, Sir James Hector, H. C. Russell, Captain Shortt, C. Todd, G. Hogben (Secretary).

Committee to report upon the evidences of Glacial Action in Australasia during the Tertiary and Post-Tertiary Eras. *Members*—Professor Hutton, R. L. Jack, Professor Tate, R. M. Johnston, Professor David (Secretary).

Committee on the Photographing of Geological Surveys. *Members*—Mr. E. P. Bishop, Professor Tate, Sir James Hector, F. Belstead, J. M. Harvey (Secretary).

Votes of thanks were unanimously passed to the following :—The Government of Tasmania, the Mayor and Alderman of Hobart, the Trustees of the Museum, the Council of the Royal Society, and Chamber of Commerce for the use of Rooms, respectively; His Excellency Sir R. G. C. Hamilton and Lady Hamilton, the Bishop and Mrs. Montgomery, His Worship the Mayor and Mrs. Reynolds, Mr. and Mrs. Henry Dobson, and others, for kind hospitality extended to the Members; the General Manager of the Government Railways, for attention and courtesy to visitors; Messrs. J. Maughan Barnett and Hubert Arnold, and the Members of the Musical Union who assisted at the concert; the Hobart and Launceston newspapers, for their full and accurate reports; and Mrs. A. Morton, for her valuable clerical assistance in preparing for the Meeting.

The following were appointed President, General Treasurers, and Officers for the years 1892-93 :—

President.—Professor Tate, F.G.S., F.L.S.

General Treasurer.—Mr. H. C. Russell, B.A.

Local Treasurer.—Mr. F. Wright.

General Secretaries.—Professor Bragg, M.A.
Professor Rennie, M.A.

Local Secretaries.—Mr. A. Morton, F.L.S., Tasmania.
Mr. J. Shirley, B.Sc., M.A., Queensland.
Professor Parker, F.R.S., ⎫
Professor Thomas, M.A., ⎬ New Zealand.
Mr. A. de B. Brandon, ⎭
Mr. A. H. Lucas, B.Sc., Victoria.

A special vote of thanks was given to the Permanent Hon. Secretary, Professor Liversidge, for his great courtesy; also to the Reporters of the Press for their careful and accurate reports of proceedings.

TABLE showing the Number of Members present, Receipts to, and Grants made at the Annual Meetings of the Association.

Date of Meeting.	*Place of Meeting.*	*President.*	*Secretary.*	Attended by						*Amount received up to and during Meeting.*	*Sums paid on account of Grants for Scientific purposes.*
				Old Life Members.	*New Life Members.*	*Annual Members.*	*Ladies.*	*Visitors.*	*Total.*	£ s. d.	£ s. d.
1888 { August Sept.	Sydney, New South Wales	H. C. Russell, B.A., F.R.S.	A. Liversidge, M.A., F.R.S. George Bennett, M.D., F.L.S., F.Z.S.	—	—	805	45	—	850	858 8 0	
1890—Jan.	Melbourne, Victoria	Baron von Mueller, K.C.M.G., F.R.S., Ph.D.	W. Baldwin-Spencer, M.A.	—	—	1081	81	—	1162	2084 0 0	
1891	Christchurch, N. Zealand	Sir James Hector, K.C.M.G., F.R.S.	F. W. Hutton, F.R.S., F.G.S., C.M.Z.S.	—	—	—	—	—	550	785 13 7	25 0 0
1892—Jan.	Hobart, Tasmania	His Excellency Sir Robert G. C. Hamilton, K.C.B., LL.D.	A. Morton, F.L.S.	—	—	—	—	—	600	933 16 3	

THE AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The Hon. Treasurer's Account of Receipts and Expenditure for Hobart Meeting, 1892.

1892.	Dr.	£	s.	d.
Jan. 14.	To Government Subsidy	500	0	0
	Subscriptions	375	5	0
	Sale of Excursion Tickets	13	10	0
	„ Luncheon Tickets	28	4	0
	Received from Hon. Sec. S.A.	16	17	3
		£933	16	3

1892.	Cr.	£	s.	d.
Jan. 14.	By General Expenses	289	8	0
	Excursions	99	12	0
	Printing and Stationery	164	1	9
	Cheque Book and Exchange	1	6	10
	Balance per Bank Book	379	7	8
		£933	16	3

Audited and found correct.

JOHN F. ECHLIN.

18th Aug. 1892.

E. & O. E.

JAMES B. WALKER, *Local Treasurer.*

DONATIONS to the Library of the Australasian Association for the Advancement of Science, from April, 1888, to June 30th, 1892.

(The Names of Donors are in Italics).

ADELAIDE.	Royal Society of South Australia:—Transactions and Proceedings and Report. Vol. viii., 1884-5.	*The Society.*
	Geological Survey of South Australia:—	
	Journey from Adelaide to Hale River. By H. Y. L. Brown, 1889.	*The Government Geologist.*
	Geological Examination of Country in the neighbourhood of Alice Springs. By H. Y. L. Brown, 1890.	,,
	Journey from Warrina to Musgrave Ranges. By H. Y. L. Brown, 1890.	,,
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PURCHASED.

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INAUGURAL ADDRESS

BY

SIR ROBERT G. C. HAMILTON, K.C.B., LL.D.,

GOVERNOR OF TASMANIA,

PRESIDENT,

HOBART, THURSDAY, 7TH JANUARY, 1892.

First, it is my pleasing duty, as Her Majesty's Representative in Tasmania, and on behalf of the Colony, to tender to the Members of the Australasian Association for the Advancement of Science from the other Australasian Colonies a hearty welcome on their assembling in Hobart to hold the Fourth Annual Session of the Association. So important and influential a gathering as this of scientific persons, and of persons interested in the pursuit of science, has, I believe, never before assembled in Australasia, and I assure you that I deeply feel my inability to do justice to the high position of President to which, by your kindness, I have been elected. I take the greatest interest in every movement or undertaking which tends in the direction of the progress and advancement of science, and, so far as I have had opportunity during my residence in Tasmania, I have endeavoured to use any influence I may possess in that direction. But I can lay no claim whatever to being regarded as a man of science. This being so, when the Australasian Association for the Advancement of Science were good enough to ask me to preside at this annual gathering I hesitated to accept the honour, as I thought it most desirable, and, indeed, almost essential, that the President should be a man eminent in some branch of science. When pressed, however, to accept the office, and having agreed to do so, I looked about me to see in what direction as your President I could best advance the interests of the Association. Now, one of the objects of the

Association being to promote the intercourse of those who cultivate science in different parts of the Australasian Colonies with one another, and with philosophers outside of our borders, it occurred to me that I should be rendering a good service to the Association if I could induce some eminent men of science from the Old Country to take part in our proceedings; and it is with the greatest satisfaction that I have been able to arrange that my friend Mr. Robert Giffen, C.B., who, as you know, is one of the highest living authorities on statistical and economic science, should pay a visit to Australia at this time and attend this gathering.

As regards this branch of science, there never was a time in the history of the world when there was a greater necessity than there is now for a wider and clearer conception of economic truths, for problems of the gravest import are pressing for solution. While, on the one hand, no adjustment of these problems based upon selfishness and individual aggrandisement, or which does not recognise *duties* as well as *rights*, can or ought to stand, on the other, there is no small danger that an unwise acceptance of some of the more advanced of what are commonly called socialistic views might lead to the motives of human energy and of human exertion being so lessened as to materially interfere, for a time at least, with the progress and advancement of the human race. I am not one of those who apprehend catastrophe arising in the inevitable development of a new industrial and social system, but if catastrophe does arise it will arise from want of knowledge, and not, as some fear, from the prevalence of any spirit of anarchy. A wider and sounder knowledge of economic truths will, however, in my humble judgment, in process of time lead not only to a satisfactory solution of present social difficulties, but will tend to develop conditions under which culture will be brought more within the reach of all. We will all listen, I am sure, with the greatest interest to any observations on economic or statistical science which may be addressed to us by so great an authority as Mr. Giffen.

At one time I had great hopes that we should have been favoured by the presence of Professor Huxley at this gathering, but the state of his health unfortunately was such as not to allow of his paying us a visit. I had hoped also that Sir Robert Ball, the Astronomer Royal of Ireland, might have

been with us, but he also was unavoidably prevented from coming. He has, however, with great kindness, sent us a very important paper on "The Astronomical Explanation of a Glacial Period," which I shall have great pleasure in reading to the Astronomical Section. Then I have had a most interesting letter from Sir Lyon Playfair, which I shall read to this meeting later on; and I can only express my regret, in which, I am sure, you join, that these gentlemen are not here present in person amongst us on this occasion.

Having done what I could to bring men of science from the Old Country into direct communication with this Association at this gathering, I had next to consider and determine what I should make the subject of my address to you this evening, and it seemed to me that some account of the rise and operations of the Scientific Societies of Australasia would be interesting and useful to the Association. I soon arrived at the conclusion, however, that I had set myself too ambitious a task. Even had I been able—and this is very doubtful—to have confined my account within the limits which time imposes upon the length of an inaugural address, I found that I could not have done justice to my subject, notwithstanding the ready assistance I received on all sides, without visiting each colony, not only for the purpose of inspecting the various records, but also of gathering some further knowledge of the lives and labours of their men of science, past and present, than could be gained from a mere perusal of volumes of proceedings. It was, of course, out of my power to visit all the other Australasian Colonies, and had I attempted to gain all the sort of information I wanted from my kind informants, I should have thrown quite an unreasonable amount of work upon them, and, in fact, the work I set myself to do would have been theirs and not mine. In these circumstances I felt compelled to abandon the idea; but I have got together a large amount of valuable information, more or less of a statistical character, respecting the various scientific societies of Australasia, which I have handed over to our Honorary Secretary, Professor Liversidge, and I hope that either he, or some other person equally capable, may hereafter see their way to compile a history of the rise and operations of the Scientific Societies of Australasia. I then determined to restrict my paper to Tasmania, which, I think, in its experiences in respect of its efforts in the cause of science, may be taken as more or less typical of

the other Australasian Colonies; and although I fear my address may not prove so generally interesting as I think it would have done could I have carried out my original idea, still I hope it may not be without some interest and value. The subject I have chosen for it may, I think, be regarded as fairly falling under the object of this Association which I have already quoted, viz., "promoting the intercourse of those who cultivate science in different parts of the Australasian Colonies with one another." Of course, the first obvious meaning of intercourse is communication or exchange of ideas between living people. But surely, we, of all people—we who are banded together for the advancement of science in these colonies—are deeply interested in the efforts made in this direction by those who have preceded us; and if for a time this evening I can bring you into contact with the thoughts and work of those who have trod the same paths as we are treading, even although many of them may be no longer with us, I may claim to be promoting that intercourse which it is one of the objects of the Association to secure and advance. It is not, I think, unworthy of this great meeting that they should turn their eyes back to the times when the difficulties attending the prosecution of science in these colonies were infinitely greater than they are at present,—when there were scarcely any libraries and but few books available; when the distance from European centres of thought was not bridged over, as it is now, by steam and electricity; when few men had leisure, and the population was not a tithe of what it now is. Even in those days in these colonies were to be found men, many of them in moments snatched from avocations not unfrequently involving hard manual toil, who devoted their best powers to scientific observation and investigation. All honour to these men, who did so much and such good work in the cause of science amidst surroundings often uncongenial!

In Tasmania we have but one scientific society—the Royal Society of Tasmania. There is another society, started last year in Launceston, called the Natural Science Society, of which we have hopes, but it is yet in its infancy. The Royal Society, or rather what was the forerunner of the Royal Society, had its origin in the days of a very distinguished predecessor of mine, Sir John Franklin. Sir John Franklin was, in 1836, appointed Governor of Tasmania, a post which he held till August of 1843. Born in 1786, he entered the

navy in 1800. He did his fair share of fighting, but, even in the early years of the century, while we were still at war with France, he was employed in the *Investigator*, under his relative, Captain Flinders, in exploring and surveying the coasts of Australia. After peace was established he turned his attention exclusively to the scientific branch of his profession, and he was employed in more than one expedition of discovery in the Arctic Seas. During his tenure of office as Governor of Tasmania he did much for the cause of education and of science in the Colony. In 1838 he founded a scientific society, which met under his auspices in Government House. This society, which was the forerunner of the Royal Society of Tasmania, was called the Tasmanian Society, and was formed with the view of stimulating scientific study and of assisting research. Sir John Franklin left the Colony towards the end of 1843, and in 1845 he started on his ill-fated expedition to the Arctic regions. The history of this expedition is, of course, well known to all. The whole expedition perished; but to Sir John Franklin belongs the honour of having been the first discoverer of the North-West Passage. A noble monument, in one of the most prominent sites in London, commemorates his heroic deeds, and a statue stands in Franklin Square, in this city, erected by the colonists of Tasmania in affectionate remembrance of their former Governor. Even now, after the lapse of fifty years, Sir John Franklin's influence is still felt in Tasmania. As an indication of that influence, it is interesting to note that when our worthy Premier, Mr. Fysh, was asked a short time ago by the Royal Society if he would recommend the Tasmanian Parliament to contribute its quota towards the expense of the forthcoming Antarctic expedition—a request to which, I am happy to say, he acceded—he said: "The monument they had erected in the Public Square to the memory of Sir John Franklin should indicate the spirit in which the Colony would deal with this question. That which was most noble in his life, and formed the great object for which his life was given, the people here should sympathise with and support. We should possess in vain the statue standing in Franklin Square if we did not feel the deepest interest in any future Antarctic discovery." Sir John Franklin himself was a distinguished man of science, but many—in fact, the bulk—of his colleagues in the Tasmanian Society were men whose daily avocations left them but little time for scientific pursuits. What the founders of this Society say of themselves is to be

found in an introductory paper, written by the Rev. Dr. Lillie, in the first volume of the *Tasmanian Journal*, published in 1842:—"The members of the Tasmanian Society would not be understood as holding forth pretensions to the ambitious appellation of *philosophers*, in the modern acceptation of the term. On the contrary, they are deeply sensible that, in matters of science, they are rather to be estimated by the sincerity and fondness of their attachment, than either the strength of their powers or the extent of their actual attainments. Most of them are actively engaged in professional and other necessary duties, which render it impossible for them to give more than a very limited share of their attention to scientific pursuits; and all of them labour under the great disadvantage of a wide separation from the philosophical institutions and men of science in Europe. Living in this new and remote quarter of the world, where there is so much to awaken curiosity, they were naturally led, by the very novelty of the subjects, as well as for the sake of their own mental improvement, to devote their few leisure moments to the study of external Nature; and, in coming thus broadly before the public, their object has principally been, besides stimulating and giving method and scope to their own exertions, to incite and cherish a kindred spirit of inquiry among their fellow-colonists. Under the conviction that they are now living at the fountain head of what promises ere long to swell into a mighty stream of civilization, they have been anxious to impress upon that stream, while it is yet susceptible of it, a salutary direction towards liberal and scientific pursuits. And the hope which especially animates them is, that their exertions, humble and feeble as they are, may be the means of rousing abler minds to put forth their energies in the same noble cause. They consider themselves only in the light of pioneers, humbly leading the way to the accomplishment of a most worthy and desirable end; and, while they are conscious of the slenderness of their resources for such an important object, they are not without hopes that the excellence of their design will in some measure atone for the imperfection and faultiness of its execution."

As regards the writer of these words—the Rev. Dr. Lillie—who was a very remarkable man, something beyond a mere passing notice is required. Born and educated in Scotland, Dr. Lillie came out to Tasmania in 1837 as Minister of

St. Andrew's Presbyterian Church in Hobart. He was a man of rare eloquence, as well as of great grasp and power, and his influence in directing the public mind into higher channels than are occupied by the mere desire for the accumulation of wealth, by awakening it to objects of liberal and scientific enquiry, and by enlarging on the advantages arising from the possession of an enlightened and well disciplined understanding, must have had a beneficial effect on the minds of the rising community of Tasmania. He was constantly inculcating the maxim that a community, not less than an individual, must look to itself for the means of developing its resources and forming and establishing its character. "It is not what stands in casual and adventitious connection with us, but what grows out of us—the living and genuine offspring of our own social organisation—which must ultimately give us our place and name among the nations of the world." As President of the Van Diemen's Land Mechanics' Institute, he delivered addresses on "The Advantages of Science," on "The Opportunities of Intellectual Improvement, chiefly with reference to the circumstances of this Community," and on "Knowledge as the means of correcting Prejudice," which are models of clear and vigorous thought, and show a true appreciation of the lofty aims and objects of scientific training and teaching. These addresses, which are as true and as applicable to the circumstances of the community now as the day they were written, would be well worthy of republication. They are the only published addresses by him of the sort which I have been able to obtain; but he was indefatigable as a lecturer on scientific subjects, and he devoted much time and thought to the furtherance of education generally, and especially to the necessity of directing it into proper channels. He left the Colony in 1858, and died in New Zealand in 1866 at the age of 59. I hope that some sympathetic hand may yet be found to write some account of his life and work, and to rescue from oblivion such lectures of his as are still to be found in scattered pamphlets published at the time. In compiling the foregoing particulars of the life and work of Dr. Lillie I have received much assistance from Mr. Livingstone, of this city, who acted in early life as Dr. Lillie's secretary—assistance which has been most heartily rendered to me as a tribute of love to the memory of his old master.

The main object of the founders of the Tasmanian Society was to encourage investigation into the plant and animal life

of Tasmania, and into the mineralogical character and fossil contents of its rocks, and to obtain, so far as possible, faithful and trustworthy records of the interesting forms and laws under which mineral, plant, and vegetable existence exhibit themselves in Tasmania. They thus hoped to prepare and accumulate materials for future and more advanced inquirers to operate upon.

It is interesting to notice that the first list of corresponding Members of this Society contained some very distinguished names. Among them are to be found those of Captain James C. Ross, of H.M.S. *Erebus*, and Captain Francis R. M. Crozier, of H.M.S. *Terror*. Both these ships, as you are no doubt aware, visited Hobart on their outward voyage to the Antarctic regions in 1840, and on their return from those regions in 1841, after having ascertained the true position of the south magnetic pole. The list also includes the names of Mr. W. Macleay, of Sydney, a learned zoologist, and the father of Sir William Macleay, whose recent death we so deeply deplore,—no man in the present generation having done so much for the advancement of science in Australia; of Count Strzelecki, of London, the eminent zoologist; and of Mr. John Gould, of London, the great ornithologist, whose magnificent work on Birds is not only of rare artistic merit, but is still the standard work on the subject. All of these are no longer living. But three of the original corresponding Members of this Society still retain their health and vigour. They are the Rev. W. Colenso, whose investigations in botany and zoology, extending over a very lengthened period in New Zealand, have been very important and extensive, and who, moreover, is the greatest living authority on the folk lore of the Maories; Sir George Grey, whose brilliant services in his riper years in the political world have a tendency to somewhat cast in the shade services, scarcely less brilliant, which, as a younger man, he rendered in the field of exploration; and last, and by no means least, Sir Joseph Hooker, then the Assistant-Surgeon of H.M.S. *Erebus*; and it is no small satisfaction to Tasmanians that a man of the extraordinary powers and attainments of Sir Joseph Hooker should have devoted so much of them as he has done to the investigation and description of the nature, distribution, and affinities of the Tasmanian Flora.

As regards the *resident* Members of the Tasmanian Society whose names appear in its first published list, in addition to

those of Sir John Franklin and the Rev. Dr. Lillie, to whom I have already referred, I find the names of the Rev. T. J. Ewing, Mr. Ronald C. Gunn, and Dr. Joseph Milligan, who were noble pioneers in the cause of science in Tasmania,—men whose hearts never failed them amid discouragements and difficulties, and who built up much of the knowledge we now possess of the botany, zoology, and geology of Tasmania. Of the original resident Members three still, I am happy to say, are with us. One of them is a lady, Mrs. Allport, whose son, Mr. Morton Allport, was a mainstay of the Royal Society for many years, and in whose death, in 1878, at the comparatively early age of forty-seven, Tasmania suffered a serious loss. The two other surviving Members are Vice-Presidents of Sections of this Association, and both still retain their connection with the Royal Society. The one, Mr. James Barnard, is a Vice-President of our Anthropological Section, and Vice-President also of the Royal Society; the other, the Hon. J. W. Agnew, is a Vice-President of our Literature and Fine Arts Section, and is now, and has been since July, 1861, the Honorary Secretary of the Royal Society. Both of these gentlemen have worked energetically and unremittingly in the cause of science for upwards of fifty years, and I hope—and I think I may venture to say that you, ladies and gentlemen, share in that hope—that the day may be long distant when they will have to cease from their labours. To-day must be a proud day for them, as they throw their minds back for fifty years and see how, from small beginnings in the different Colonies, a growth has now been reached which makes it possible for a grand gathering of this sort to be held in Hobart in this year of grace 1892.

The early pioneers in the cause of science were fully impressed by the special necessity which exists for the cultivation of scientific knowledge in a new country like Australia in order to make the most of its natural advantages, being alive to the fact that labour will be most productive when the objects it aims at, and the form and method of their applications, are in strictest accordance with the conditions which nature has established. But the advantages which they anticipated from the proceedings of this Society, and their publication in the Colony, were by no means limited to those which were purely material. Wise men were these early pioneers, and what they say on this subject is as true

now as it was fifty years ago:—"The circulation of a Journal of Science, upon matters of local interest, among the inhabitants of this rising country, is calculated to produce a most salutary effect upon their character: by leading them to the study of Nature, and habituating them to reflect on the interesting objects around them, it would afford valuable exercise to their mental powers, and open up new and productive sources of pleasure and enjoyment. The situation of a settler in Australia is particularly in want of such a stimulus. He is not unfrequently a man of intelligence and education; but, living in comparative seclusion, and far removed from the stirring scenes and transactions of European society, his mind is apt to become relaxed and lose its former tone and vigour, or to be narrowed and contracted by exclusive converse with petty details, or, still worse, to be given up to the sordid passion for accumulating wealth. In such circumstances, whatever would tend, like the Journal in question, to excite his attention to, and lead him to find an interest and pleasure in, the events and appearances of surrounding Nature, could not fail to be peculiarly beneficial. It would serve to alleviate the monotony and tediousness of his situation—to prevent the inactivity and consequent deterioration of his mental faculties—to counteract the powers of ungenerous and debasing passions, and to add the dignity of a cultivated and well-informed mind to the simplicity of rural occupations and sequestered life."

Among the earliest papers furnished to the Tasmanian Society were—"Remarks on the Indigenous Vegetable Productions of Tasmania available as Food for Man," by Ronald C. Gunn; "A Catalogue of the Birds of Tasmania," by the Rev. T. J. Ewing; "Description of a Collection of Fish found at Port Arthur," by John Richardson; "Irrigation of Tasmania," by Captain A. F. Cotton; Series of Meteorological Observations at Hobart, Launceston, and Port Arthur;" "Characteristics of the Aborigines of Tasmania," by the Rev. T. Dove; "On the First Discovery of Tasmania in 1642," by the Rev. J. P. Gell; "On the Teeth and Poison Apparatus of Snakes," by Dr. J. W. Agnew—who, as I have said, is now one of our Vice-Presidents; and "On the Statistics of Van Diemen's Land," by Mr. James Barnard, another of our Vice-Presidents. You will observe, ladies and gentlemen, that the range of subjects, even in these early days, was fairly extensive. I have merely quoted the titles

of a few of the papers submitted, to show the class of subjects which appears first to have attracted the attention of these early pioneers in the cause of science. But the papers were by no means purely confined to Tasmanian subjects. A good deal of the space in the early Journals of the Society is occupied by papers on the results of the then recent Antarctic exploration by the *Erebus* and *Terror*, and on contemporary exploration and observation in the Australian Continent and New Zealand, interspersed with papers and notices on various subjects of general interest, under the heading of "Miscellanea." In this class I find notes and papers on such subjects as the Discovery of the Daguerrotype; on Solar Radiation; on Terrestrial Magnetism; and on Smelting by Electricity. The original meetings of the Society appear to have been held altogether at Government House during Sir John Franklin's time; and, when his term of office came to a close, there was quite a touching leave-taking between him and the Members, who presented him with an address, in which they said, "the friends of science have, upon this and no other claim, ever been treated as your personal friends, and admitted to your domestic circle."

The Tasmanian Society existed under the same name till 1848; but in 1843 another society came to the front, viz., the Society of Van Diemen's Land for Horticulture, Botany, and the Advancement of Science. The leading objects of this Society, of which Her Majesty was graciously pleased to become the Patron, and to allow it to be called "The Royal Society of Tasmania," were, and still are, "to investigate the Physical Character of the Island, and illustrate its Natural History and Productions." In the published Report of the Tasmanian Society for 1845 I find the following passage:—"Whether so small a community as this can efficiently support two scientific Societies having similar objects in view, or whether the Royal Society of Van Diemen's Land, with its patronage from the Queen, grant of land, and allowance of £400 per annum from the funds of the Colony, may not eventually supersede and swamp the self-supporting and unostentatious Tasmanian Society, that has pursued the even tenor of its way for the past seven years, must remain for the present unanswered. We are too sincerely attached to the cause of science to regret that there are an increased number of

labourers in the wide field of nature to gather its flowers; and we can only hope that, by the joint exertions of the two Societies, the natural history, productions, and resources of these Colonies, and those of Tasmania in particular, may ere long be thoroughly investigated, described, and published." The two Societies did not, however, last long side by side. The younger, in a short space of time, swallowed up the elder, absorbing its members; and in 1848, or early in 1849, the Tasmanian Society came to an end. There seems, however, to have been some sort of understanding between these Societies, for I find that the published Reports of their proceedings do not overlap each other,—those of the Tasmanian Society coming to a close on 10th May, 1848, and those of the Royal Society starting from 16th August of the same year. Meantime the Royal Society appears to have been growing in strength. It possessed the great advantages of receiving an annual grant from the Government, and of having an allotment of land in the Domain for the purpose of creating a Botanical Garden, of which considerable use apparently was made in the direction of experiments, both in the naturalisation and acclimatisation of such exotic trees, fruits, and plants as it might be in any way useful or desirable to introduce into the Colony, and on the capabilities of indigenous plants to improve by cultivation.

The Royal Society was fortunate in its officers. It had the advantage of having first as its Secretary Dr. Lillie, of whom I have already spoken, and afterwards of Dr. Milligan; and Sir John Franklin's successors, Sir Eardley Wilmot and Sir William Denison, both extended to it their fullest support. So important a body had it become by 1850 that, when the Governor in that year received a Despatch from the Secretary of State, desiring that specimens of the native and industrial products of the Colony should be procured and sent for exhibition at the first Great Exhibition of the Industries of all Nations, to be held in London in 1851, he at once summoned a meeting of the Royal Society to devise the ways and means of most effectually accomplishing this object. The matter was then taken in hand by the Royal Society, and successfully carried through by them; and the interest taken by the Governor in the undertaking is shown by the fact that the exhibits, before their despatch to England, were collected together and were on view to the public for five days in the Ball Room of Government House.

The first mention I find of a Museum is in 1849, in which year a grant of £100 was given by the Government towards its support. From this small beginning a collection has gradually been got together which, as I think you will agree with me after you have inspected it, is a credit to Tasmania, in so far as the illustration of the natural history and mineralogy of the Colony is concerned. The Museum in its early days owed much to the exertions of Dr. Joseph Milligan, to whom I have already referred as the successor of Dr. Lillie in the post of Secretary to the Royal Society, and to whose geological work I shall make reference hereafter. Dr. Milligan left the Colony in 1860, but he always retained an active interest in the Society; and at his death, in 1884, he bequeathed it a handsome legacy. No doubt all of you will visit this Museum; and I would direct your special attention to the arrangement and classification of its specimens. It is doubtless known to many of you that Professor Flower, F.R.S., who was the President of the British Association in 1888, devoted a large portion of his inaugural address to describing the principles which should govern the classification and description of specimens in Museums; and it is no small credit to Tasmania that, in this respect, she should have been, long before the delivery of the learned Professor's address, proceeding closely upon the lines laid down by him.

I may here digress for one moment to say that, on 30th April of last year, I had the privilege of opening a new Museum and Art Gallery in Launceston. It is, of course, quite in its infancy yet; but it is under the superintendence of our Curator, Mr. Morton, and will be developed upon precisely similar lines to those adopted here.

The Museum and Botanical Gardens remained connected with the Royal Society, and under their superintendence, till the year 1885, when an Act of Parliament was passed, placing them under a Board of Trustees. Most of the Members of this Board, however, are Members of the Royal Society, and perfect harmony exists between the two institutions. Owing to want of space and want of funds, our Botanic Gardens have not been so useful in the past, from a scientific point of view, as we hope they will be in the future. A good deal has been done in the way of gathering together a number of ornamental and useful plants, fruit-trees, &c., with the view of determining their suitability or otherwise for reproduction in

the Colony; but little has hitherto been possible in the direction of making these gardens a place of systematic illustration of all the plant life which Tasmania is capable of supporting, and of making them, further, a centre for the botanical instruction of the public. The steps which should be taken to secure these objects have been well detailed in a Report made by the Director, Mr. Abbott, to the Government, in 1885. The Government thus are in full possession of what ought to be done; and, as our revenue increases by the development of the resources of the country, particularly the mineral resources, which are now giving such extraordinary promise of wealth, I feel sure that more funds will be allotted to the support of these gardens; while the additional space required for their development could easily be gained by extending the gardens further into the Domain, and, perhaps, by a small curtailment of the extensive grounds now allotted to the Governor's residence.

In a necessarily brief review like the present, it is obviously impossible for me to refer in detail to the multifarious work of the Society. The volumes of proceedings are full of interesting papers—geographical, ethnological, astronomical, and meteorological—and contain some valuable work on economic science. Time would fail me to do more than simply to state that much work of value and usefulness has been submitted on these subjects, and that many of the papers on them exhibit careful observation and much skill, ingenuity, and originality in treatment. But, having regard to the fact that the main reason why the Royal Society came into existence was to investigate the physical characteristics of the Island, I think you will expect that I should sketch briefly the progress made, since its inception, in the knowledge which we possess of the geology, mineralogy, and natural history of Tasmania. But, before doing so, I should like to refer to two directions in which the operations of the Society have a great interest and value to the community at large. First, it has been the means, mainly through the excellent work of Mr. J. B. Walker, of bringing together the scattered records of the early discovery and settlement of the Island; and second, it has taken a leading part in the acclimatisation of *Salmonidæ* in Tasmanian waters. This latter has been a most successful and useful work. For, whether or not we have succeeded in reproducing the true *Salmo salar*, our rivers and lakes are now fast becoming stocked with Salmonoids

which afford excellent sport to the angler, and will doubtless, as time goes on, prove a considerable source of wealth to the Island, not only by introducing a new and palatable item of food supply, but by attracting to our shores many visitors in pursuit of sport. In connexion with this subject, I cannot refrain from referring to the munificence of the Honorable J. W. Agnew, (of whose other services to the Royal Society in various directions I have already more than once made mention in this address), who, entirely at his own cost, secured the introduction of an enormous supply of salmon ova in 1888, which was stripped from the parent fish and brought to Tasmania by Sir Thomas Brady, and deposited in our breeding-places under his personal superintendence. We are anxiously awaiting the result of this latest experiment, and hope it will be the means of finally settling in the affirmative the long and much debated question as to whether or not the true *Salmo salar* is an inhabitant of the Tasmanian waters.

As regards the progress made in the knowledge of the Geology of Tasmania during the last fifty years, I am indebted to Mr. R. M. Johnston for the following particulars:—"The influence of the Royal Society upon the development of the Geology of Tasmania may be most fully expressed by the statement that the whole of our present knowledge has been either directly due to the investigations of its Members and Associates, or has been derived from the material which they have collected. Prior to the foundation of the Society, Tasmania was a sealed book to the geologist. Nothing was known of the rich mineral resources, whose development in recent years has so largely added to our commercial prosperity. The exact age, character, extent, relationship, and palæontology of its different systems of rocks had never engaged the attention of a single scientific observer. Nor is this to be wondered at when we consider the nature of the country and its condition at this stage of its history. Its whole surface, except the very limited clearings about the settlements, was trackless, and, to a large extent, enveloped in dense and almost impenetrable forest or scrub. Even between the two principal centres of population, Hobart and Launceston, the means of communication only six years previously were so defective that the mails had to be carried by foot-post once a fortnight. It can be imagined, therefore, that the pioneers of geological explorations in Tasmania had to contend with difficulties

undreamt of by the pioneers of investigation in old settled or inhabited countries. One of our pioneer explorers of the western highlands gives the following description of the ordinary difficulties which his party had to contend with. He states: 'Apart from the never-ending rugged mountains, gullies, and ravines to be traversed, and the dangerous rapids to cross, the intermediate plateaux and mountain slopes in Tasmania are often so continuously clothed with a dense and luxurious growth of vegetation (horizontal and bauera scrub) that it is impossible to pursue a course on foot in one direction for any distance without literally, axe in hand, cutting or hacking a track sufficiently wide to admit of squeezing the body through. This is not an easy matter, as each individual is of necessity encumbered with a heavy knapsack of from 60 to 70 lbs. weight. This knapsack, or portable storehouse, must contain all the essentials for providing shelter and food (small tent and bare necessaries) for the individual for a period of at least six weeks, as no friendly dwelling or bushman's camp is likely to be met with until he returns to his point of original departure.'

"The distinguished traveller, Count P. E. de Strzelecki, was the first person who explored a considerable portion of this Island for the express purpose of investigating its geological and mineralogical character. The extent of his observations may be best appreciated when we consider that his journeyings *on foot* in New South Wales and Tasmania, over a period of five years, are estimated to have amounted in all to a length of 7000 miles, or about 116 miles per month. It is true that the greater part of his travels did not extend far beyond the tracks or bush roads of the earlier settlers; but the information gathered by him was extensive and valuable, and formed the material which, a short time after (year 1845), enabled him to publish the first systematic sketch of the geology and general physical character of Australia and Tasmania.

"About the same time another distinguished traveller and geologist, J. Beete Jukes, examined a considerable portion of our rocks in the south-eastern region of settlement; and his accurate observations, published in the same year, largely supplemented the information supplied by Count de Strzelecki.*

* Physical Description of New South Wales and Van Diemen's Land. (Maps and Returns. London; 1845.)

"The earliest local geological observer, who largely extended our information, was the late Dr. Joseph Milligan. Between the years 1851 and 1855 he contributed no less than fifteen papers on geological subjects, the most important of which were his four 'Reports on the Coal Basins of Tasmania.' In 1855 Mr. Selwyn examined the coal seams described by Dr. Milligan, and, while confirming the accuracy of Dr. Milligan's observations, he contributed original matter which was of great service in determining the stratigraphic relationship of the rocks associated with our Mesozoic coal measures.

"In the year 1860 the Colony was fortunate in securing the services of Mr. Charles Gould as Government Geologist. Mr. Gould entered upon his labours with energy and enthusiasm. He penetrated the hitherto unknown regions of the western highlands and the north-eastern district, and, amid the greatest hardship and privations, he carried on the work of exploration, which subsequently enabled him to map with considerable accuracy the characteristic rock formations and the important mineral regions of a very great portion of the Colony. Of special value are his chart and reports on the metalliferous rocks of the west and north-eastern districts of Tasmania, and to these are we indebted for the first clear revelation of the nature and distribution of gold-bearing and other metalliferous rocks, and, even now, the charts and cut tracks of Mr. Gould are of the greatest benefit to mining explorers and others; and, although his efforts to find payable gold or other minerals were not altogether successful, they were of sufficient value to direct the steps of subsequent explorers, and a large number of our subsequent discoveries of valuable minerals are in some measure due to the pioneer work done by Mr. Gould. Mr. Gould's services unfortunately were not permanently retained, but during the fourteen years in which he was more or less actively engaged in geological investigations he contributed a large part of what is now generally known of the stratigraphy and mineralogy of our rocks. He published no less than twenty-one reports or papers, with coloured charts, some of them very elaborate, and, when his services were dispensed with, he was engaged upon a most interesting survey of the western part of Tasmania, and had it been continued, it is certain that he would have done much to solve the riddle of that vast series of rocks of Archæan, Cambrian, and Silurian age, rich in minerals, lying between the Gordon Bend and

Macquarie Harbour, and stretching between Flinders' Island in the north, and Mount La Perouse in the south.

"Nor must we omit the valuable work of other local geologists and mineralogists about this period, and extending to the present time, prominent among whom are the names of Rev. J. Tenison-Woods, Messrs. M. Allport, T. Stephens, A. Hainsworth, S. H. Wintle, G. Thureau, C. P. Sprent, J. Smith, A. Montgomery, and R. M. Johnston."

In the foregoing memorandum, so kindly written for me by Mr. R. M. Johnston, he places his own name last on the list; but it is to him, and to the late Rev. J. E. Tenison-Woods, that we are indebted for the greater part of what we now know concerning the palæontology of the rocks, more especially as regards the marine organisms of the Tertiary age, while Mr. Johnston has, in addition, during the last twenty years, made a special study of the fossil plants of the Carboniferous, Mesozoic, and Tertiary rocks; and, besides his own extensive descriptions, much of the materials collected by him has been the subject of elaborate memoirs by Professor Ettingshausen, Professor Feistmantel, Professor Tate, Robert Etheridge, jun., Baron Sir Ferdinand von Mueller, and the Rev. J. E. Tenison-Woods. In Mr. Johnston's great work, "A Systematic Account of the Geology of Tasmania," published in the year 1889 by the Government of Tasmania, he gives a very comprehensive summary of the work done by all previous workers, and at the same time brings into focus all that is definitely known at present regarding the Geology, Palæontology, and Mineralogy of Tasmania. In it he has shown also that, whereas only 50 fossil species of organisms were available to aid the stratigraphist in his determination at the time when Strzelecki and Jukes concluded their labours, there are now at least 762 species described; and, although this is a small number absolutely, it embraces all the characteristic forms of our great system, and these will certainly afford valuable aid to future workers in extending our knowledge in the many regions yet awaiting the attention of the geological observer.

As regards the advance made, mainly through the instrumentality of the Royal Society, in our knowledge of the natural history of Tasmania during the same period, that is, during the last fifty years, I give the following brief record of particulars, in compiling which I have received the greatest

assistance from Mr. A. Morton, the Curator of the Museum. The *Tasmanian Journal* for 1854 gives a List of the Tasmanian Mammals known at that time, compiled by the late Mr. Ronald C. Gunn, who was a good naturalist all round, and to whom Sir Joseph Hooker dedicated his "Flora Tasmaniensis." That list comprised 30 species: we now know of 45. In 1842 the number of Birds described was 134. During the following thirteen years 35 additional species were discovered, and 24 have since been added to the list. In 1839 the list of Tasmanian Fishes numbered 30. In 1883 it had risen to 188, and it now numbers 214. Of the 716 species of Tasmanian Shells now catalogued, about 228 were described in the Society's Journals by the Rev. J. E. Tenison-Woods; and Messrs. Legrand and W. F. Petterd, whose names as conchologists are widely known, have also furnished most valuable information on the Land Shells of Tasmania. The contributions to the study of Tasmanian Flora in the Journals of the Royal Society are many and varied. Sir James Hooker, Baron Sir Ferdinand von Mueller, the Rev. W. W. Spicer, and R. M. Johnston are prominent names on these papers. Of the 87 papers on Botany which our records contain, at least 20 have been written by Baron Sir Ferdinand von Mueller, who, as we all know, for the last forty-four years has been labouring assiduously at the Australian and Tasmanian Flora. The Tasmanian Flora numbers now about 100 orders, 478 genera, and over 1100 species. In ferns alone Mr. Morton's excellent catalogue, as read before the Society in 1890, shows 77 species known to Tasmania. Our Entomology has scarcely received the attention it deserves,—only fourteen papers having been contributed on the subject. Yet that there is a large field for work in this direction is abundantly proved by the fact that Mr. W. W. Walker, R.N., Chief Engineer of H.M.S. *Penguin*, while on a visit here last year, obtained no fewer than 586 species of Coleoptera from Hobart, and 1871 specimens of 798 species from all Tasmania. Many of these were new to science; and the great bulk of them were obtained by him in the immediate vicinity of Hobart, in moments of leisure snatched from his professional duties.

I have heard it urged as an excuse for the comparative paucity of contributions of local observations on natural history to our scientific societies that, practically, this work has been

accomplished. There could be no greater error. All we know is but an incomplete fringe of what remains to be known. Even if we had absolutely complete records of all descriptions of animal and plant life in these Colonies—and this we are very far from having at present—we should only then be at the commencement of our observations. As Sir John Lubbock well puts it—"to place stuffed birds and beasts in glass cases, to arrange insects in cabinets, and dried plants in drawers, is merely the drudgery and preliminary of study. To watch their habits,—to understand their relations to one another,—to study their structure and intelligence,—to ascertain their adaptations and their relations to the forces of nature,—to realize what the world appears to them: these constitute, as it seems to me at least, the true interest of natural history, and may even give us the clue to senses and perceptions of which at present we have no conception." Where there is only one Society, as there is in Tasmania, covering the whole range of physical and natural science in all their multiform departments, such a Society certainly ought never to suffer from any dearth of contributions of useful work.

In common, I fancy, with most scientific societies in Australasia, the Royal Society of Tasmania has had its periods of active and progressive work, alternated by periods when its activity was not so great; but it has been fortunate in having had a relay of careful observers of Nature, and of indefatigable workers in the cause of Science. Where so many have worked so well, it may be thought somewhat invidious to single out any names as worthy of special commendation; but I feel sure that all who are conversant with the history and work of the Royal Society of Tasmania will agree with me that of all its workers past and present none have rendered greater service than the Rev. J. E. Tenison-Woods, whose recent death was a serious blow to science, and Mr. R. M. Johnston, whose genius, versatility, and untiring industry in the cause of science are beyond all praise, and who is undoubtedly at present the mainstay of our Society. It is the lot of societies of this sort often to have to depend very largely at times upon the work of some two or three men who, indeed, seem to be indispensable to its very existence. And yet it is cheering to observe that the experience of the past shows that as, in the natural course of

events, such men disappear, somehow or other new men arise to take their place. At the present time we may congratulate ourselves on the Royal Society of Tasmania being in a healthy state, and fairly commanding the sympathy of the public, although there is plenty of room in it for more workers. We are fortunate in the fact that our leading men in society in Tasmania, both past and present, have taken an active part in the advancement of science. My various predecessors in office have for the most part closely identified themselves with the interests of the Royal Society; and, besides Sir John Franklin, who, as I have shown, played a leading part in its inception, scientific work in Tasmania owes much to the aid it received from two other Governors, who were also themselves men of science—I refer to Sir William Denison and Sir Henry Lefroy. The late Bishop Nixon, who was a man of great culture and power, lent the Society his earnest support, and the present Chief Justice, Sir Lambert Dobson, is a Member of our Council, and he and Bishop Montgomery not only frequently take part in our discussions, but also have both contributed papers to our proceedings; while the venerable Roman Catholic Archbishop, whose astronomical attainments are of a high order, is one of the Vice-Presidents of the Astronomical Section of this Association. Still, what I may call the general mind of the community does not go out toward scientific observation and investigation as I should like to see it. There is a disinclination to take trouble about, and a keen interest in, what does not obviously add directly and immediately to the wealth and comfort of the community; but I look forward to one effect of this great gathering in Hobart being to press home the conviction to the minds of our people that the more we add to our knowledge of Nature's laws the more we are able to make use of them for our benefit, often in directions quite undreamt of. Of this, at least, I am very hopeful, that even if this gathering does not, as I hope and believe it will, directly tend to increase the number of contributors to our Society, it will, at least, give a stimulus and an impetus to scientific research generally throughout Tasmania, the salutary effect of which will become more and more apparent as years roll on.

I will now read to you Sir Lyon Playfair's letter.

Atlantis Cottage, Nahant,
Massachusetts, U.S.A., 12th September, 1891.

My dear Sir Robert,

I am much pleased to learn that you are to be the President of the Australasian Association for the Advancement of Science at its next meeting in Hobart. I wish that I could offer you a visit on that occasion, as I constantly deplore the fact that I have never visited our great Australian Colonies. But my age denies me this pleasure, although you will see from my address that I am at present in the United States.

Australia has done a wise thing in founding a General Association for the Advancement of Science, because each meeting sends down healthy roots of science into the locality visited. I feel certain that Sydney, Melbourne, and Christchurch must already have felt the invigorating influences of their meetings, because I have recently received excellent scientific contributions from each of these capitals from old pupils, who I rejoice to number among your distinguished men of science.

Australia is progressing admirably, though in a short period she will look with surprise to her past dependence on her riches of raw materials. England, earlier and later than the reign of Queen Elizabeth, stood to Flanders in the same relation that Australia stands to England. We exported English wool to Flanders, and received its manufactures in payment, and did not then believe that we were destined to become a great manufacturing nation. The political crimes of Spain, in banishing the industrious Moors and Morescoes; the religious intolerance of France, in expatriating the Huguenots; and the persecution of the Protestants in the Low Countries, sent us men of practical experience, who planted the roots of manufactures in a soil of liberty. Vigorous as was their growth, they were for a long time dependent upon empirical experience, and not upon science. The improvement of locomotion by sea and by land forced upon England the conviction that industrial competition was no longer one dependent on the possession of raw materials or local advantages, but had become converted into a competition of intellect among the producers of national wealth. I laboured hard, after the Great Exhibition of 1851, to enforce this truth among the manufacturing districts. At that time outside our Universities there were only two institutions of collegiate rank in

the United Kingdom. Now there is not a manufacturing town which has not its well equipped College, chiefly for science and art, though also for general culture—which should lie at the basis of all instruction. Our technical schools for working men are also growing with great rapidity; and some of our Polytechnics, like that in Regent-street, London, have actually six or seven thousand working men studying science and art, so that they may carry on their work with that dignity and intelligence which is the characteristic of modern intellectual competition in industry. The farmers have been the last among our producers to understand the need of this change; but even they are aroused, and agricultural schools are rapidly arising throughout the country. It is a melancholy thing to see farm labourers ploughing, manuring, and reaping without the faintest scientific knowledge to illumine their empirical experience. They know that the crops grown will feed the labourers; but ask them what feeds their crops, and they are generally in crass ignorance. They are content to know that the soil, "muck," and rain are necessary. But ask them how is it that the tree stretches out its arms to heaven to pray for food, and by what wonderful dispensation the transparent air builds up the body of the tree, and how the roots, like foragers, push their way into the soil and secure certain necessary ingredients for the crop, and how it is that manure furnishes what is lacking, and the eye of the bucolic becomes like the lack-lustre eye of an ox—content to survey only his immediate surroundings. All this is changing in England since you left for Tasmania; and there is a far greater demand for agricultural teachers than we can supply, although our Technical Association has foreseen that the demand was coming.

Australia is not a country which has had either the benefits or defects of ages of empirical experience. You have become a nation at the time when the older countries had discovered that long experience no longer sufficed, but that science must go hand in hand with practice in the pursuit of industrial wealth. The abundance of natural resources and vast territorial possessions retarded the intellectual growth of the United States, which already finds the need of science in all its industrial undertakings; and, with its characteristic energy, is developing its scientific education and its institutions for the promotion of scientific discovery.

Everything which promotes human culture developes

national intelligence, and that is the main condition for national development. Scientific discoverers justly are indignant at the question *cui bono* do your discoveries tend? Faraday was once asked this question in regard to one of his new electrical discoveries, and he replied, "What is the use of a baby?" Yet this useless young naked mammal has all the care and sentiment of its parents when young, and even the State interferes in its upbringing so that it may become a useful and productive citizen.

Abstract science, which your Association endeavours to promote, is the basis of human progress, and should be encouraged for its own sake. It is the tree of knowledge, which will produce industrial fruit in its appointed season. Let Australia encourage science for its own sake, and, as a nation, it will in due time receive ample national reward.

I hope that your meeting will be eminently successful. Be sure to send me your Address.

Yours, ever sincerely,

LYON PLAYFAIR.

A few observations in conclusion. The arrangement under which this Association changes its place of meeting each year is one which undoubtedly adds greatly to its usefulness, to its vigour and freshness. Old Members renew their acquaintance with one another at their annual gatherings, amid new and interesting surroundings, and they make the acquaintance of local workers who rarely move far from home, from whom they gain much fresh local knowledge; while these, on their part, are stirred into life and activity by the presence among them of men from whom they can learn so much, and from associating with whom their whole conceptions of Nature's laws are widened and enlarged. The British Association, on which our Association is modelled, has so long outlived and lived down the sarcasms which used at one time to be levelled at it as an institution to enable men and women to play at science, that the attitude of mind which so regarded it would be scarcely intelligible to this generation were it not for the survival still amongst us of some, not of the fittest, who scorn the idea of any good arising to the cause of science from these periodical assemblies of men and women, of whom comparatively few are themselves scientific. They say, "Let women keep to their domestic duties, and us to our several businesses; leave science to

professors and others whose business it is, and if they make any discoveries of benefit to us we will avail ourselves of them; but no good can arise from gatherings like these." To them I would say, "We, the bulk of the Members of this Association, although we may not ourselves have done any scientific work, are deeply interested in the progress and advancement of science, and we believe that we can do something to help this forward." As regards the admission of women as members of these Associations, it cannot be gainsaid that, in many directions, the cause of science has benefited in the past from the intellect of women being brought to bear upon it, and I believe that it will still receive more benefit in the future; while I most emphatically endorse the opinion of the President of the British Association in 1849, at which ladies were first admitted as associates, that "man cannot ascend in the scale of intellectual power unless woman rises with him." This Association brings together those who are interested in scientific pursuits with the twofold object—first, of systematising scientific inquiry; and, second, of obtaining a greater degree of public attention to the objects of science. The first is the work of men of science pure and simple; the second affords work for all of us. This gathering, I am happy to say, includes a large number of scientific men, and I trust that their deliberations on this occasion will appreciably tend towards systematising inquiry, particularly throughout the Australasian Colonies. When men are thus brought together who are interested in the same scientific pursuits, but who necessarily, for the most part, work alone, a free interchange of ideas among them is promoted, and a healthy vitality and emulation is aroused and stimulated; gaps in reasoning are supplied,—blanks in observation are filled in,—crude theories are dissipated,—and truth emerges from the crucible of wider experience, and a full discussion by free and vigorous minds. Then, again, some researches can only be successfully carried out by co-operation, and gatherings of this sort afford opportunities for organising committees for the prosecution of such researches. Most of us, however, who are assembled here this evening fall, as I have said, into the category of those who, although not ourselves workers in science, are, nevertheless, deeply impressed by the importance and necessity of its advancement, and who follow, so far as we are able to do so, its progress and triumphs with interest and delight. On us devolves the duty of doing all in our power to obtain more general and wider attention to its

objects, and to help not only to remove any disadvantages of a public kind which may impede its progress, but to secure advantages of a public kind which may facilitate it. These annual gatherings in the capitals of the various Australasian Colonies exercise a powerful influence in this respect by directing the public mind to scientific objects; but we should also individually do our utmost, each in our own sphere, to hasten the advent of the time, which is undoubtedly approaching, when science will form a much more integral part of the life of the people than it does at present. I will indicate some directions in which we can render useful service in this respect.

First, we should give all the support we can to the Royal and other scientific societies established in our respective Colonies. They are the centres of scientific life in Australasia. Those of us who may not be able to contribute any original work to them can at least show our interest and sympathy with their objects by becoming members of these societies, if not members now, and by attending their meetings. There can be no doubt that interest and sympathy help forward scientific work, as they do every other sort of work under the sun. The more these societies keep themselves before the public the better, and when the press gives full and interesting reports of their proceedings, as it does here, it is really surprising to find how, in the remotest districts of the country, interest is awakened in connection with scientific investigation and observation, which shows itself in the form ot questions and letters on points of scientific interest from all parts of the country. Nevertheless, I cannot help thinking that there is much room for increasing the usefulness of these societies by devising and systematically carrying out some organisation throughout the country for the obtaining of information respecting its physical and natural characteristics, and I should be glad if this matter were considered by the Members of this Association. I do not know whether any such organisation exists at present in any of the Australasian Colonies. It seems to me to be greatly needed, and something might be done, as suggested lately by Mr. A. J. Ogilvy to our Royal Society, by mapping the country into districts, and by appointing an honorary representative for each. This gentleman would keep his eyes and ears open, and report anything of interest to the Society, besides procuring for them any local information they wanted: while, being the recognised agent

of the Society, other residents in the district coming across matters of interest would put themselves in communication with him, and in this way much useful information would be gained which might otherwise be lost.

Second, we should take every opportunity of disseminating the great truth that even in the humblest occupation some knowledge of the sciences—which lie at the basis of all industries—enables the workman, in the words of Sir Lyon Playfair, "to dignify and fructify his labour by understanding it." Not long ago, at a farmers' meeting in this City, I tried to point out how largely science enters into the daily operations of the agriculturist; how he would be all the better for knowing something of the rudiments of geology and chemistry in dealing with his soil and manures; of engineering and mechanics in dealing with drainage and irrigation, and in the working of his labour-saving machinery; of the structure and habits of plants and animals; and of meteorology, which is fast becoming a science. And I pointed out that while now such knowledge, all things being equal, would probably enable a man to surpass his fellows, that, in the future, unless he possessed it he would inevitably fall behind them. The institution of popular lectures would do much to disseminate this sort of knowledge. These are by no means as common in Tasmania, nor, as far as I can ascertain, in Australasia generally, as they ought to be; nor is it always easy to secure good popular lecturers. Still, there is a great field open to us in helping such a movement forward. If there were a general demand for such lectures, the lecturers would somehow or other be found; and even if they were not of the first rank, they would nevertheless be able to do much good. We should therefore do what we can to stimulate this demand: and I think the minds of the public generally would easily be moved in this direction; for, besides the fact that a man is always ready to imbibe any knowledge respecting his own particular business or avocation if it is presented to him in an attractive shape, there is undoubtedly a general spirit of enquiry abroad which desires to be directed into proper channels.

Lastly, we should use all our influence, each in his own sphere, to secure that the rudiments of science are taught in our primary schools, and that science classes of a more ad-

vanced character are established in every important centre. We should, further, do what we can to promote the establishment of district museums, with collections illustrative of the mineralogy and natural history of the locality, supplemented as time goes on by further illustrative specimens from other localities, starting from our own as a basis. We should thus, by increasing the facilities available for the study of science to the young and rising generation, largely add to the number of future workers in her cause.

Let us, in addition to taking action in the practical directions which I have indicated, do all we can to impress upon those around us that there is nothing of more importance to humanity at large than that we should increase our knowledge of Nature's laws and of their operation and application to our needs. It is abundantly evident that the greater knowledge in this respect which the present century has produced has led to an enormous increase in the wealth of the world, by facilitating and enlarging both the production and distribution of commodities, and has also largely contributed to the comfort, and prolonged the duration, of human existence. I cannot refrain from here quoting, although the passage is doubtless familiar to many of you, what Macaulay says in his Essay on Bacon, of the philosophy based on observation, of which that great man was, if not the author, at least one of the ablest exponents. He says, "It has lengthened life: it has mitigated pain: it has extinguished diseases: it has increased the fertility of the soil: it has given new securities to the mariner: it has furnished new arms to the warrior: it has spanned great rivers and estuaries with bridges of form unknown to our fathers: it has guided the thunderbolt innocuously from heaven to earth: it has lighted up the night with the splendour of the day: it has extended the range of human vision: it has multiplied the power of the human muscles: it has accelerated motion: it has annihilated distance: it has facilitated intercourse, correspondence, all friendly offices, all despatch of business: it has enabled men to descend to the depths of the sea, to soar into the air, to penetrate securely into the noxious recesses of the earth, to traverse the land in cars which whirl along without horses, and the ocean in ships which sail against the wind. These are but a part of its fruits, and of its first fruits—fruits of a philosophy which never rests, which has

never attained, which is never perfect. Its law is progress. A point which yesterday was invisible is its goal to-day, and will be its starting-point to-morrow."

But it is not only from the material standpoint that the study of science should be encouraged. The advantages of scientific training to the mind are thus described by the Royal Commission on Education which sat in 1861: "Science quickens and cultivates directly the faculty of observation which, in very many persons, lies dormant through life; the power of accurate and rapid generalisation, and the mental habit of method and arrangement; it accustoms young persons to trace the sequence of cause and effect; it familiarises them with a kind of reasoning which interests them, and which they can promptly comprehend; and it is, perhaps, the best corrective for that indolence which is the vice of half-awakened minds, and which shrinks from any exertion that is not like an effort of memory purely mechanical."

Science directly tends to the elucidation of truth, which is its groundwork; and what can be more noble or ennobling than the pursuit of truth when accompanied by a fearless acceptance of its consequences? The love of truth is the greatest force in the moral elevation of the human race, and it is directly generated and fostered by the pursuit of science. The more the scientific habit of mind is cultivated, the more will a habit of absolute truthfulness be established in all relations of life. We are scarcely conscious of the extent to which misrepresentation or concealment of truth permeates society in all matters political, commercial, and social. I do not now refer so much to that sort of misrepresentation which would lead a man to be regarded as a liar, as to the conventional want of truthfulness, or the communication of half truths only, of which society generally is so tolerant. Nor is it easy to conceive what the world would become if falsehood and deceit were as rare as robbery or murder, and the intentional conveying of a wrong impression, or the permitting of a wrong impression to be received, were regarded as utterly base and criminal. A scientific training of the mind must work in this direction, for it is based on truth, and is incompatible with any connivance at or toleration of conscious misrepresentation in any shape or form.

On all grounds, therefore—material, mental, and moral—the study of science should be encouraged to the utmost of our power. And the range of science is illimitable. Notwithstanding the accumulated knowledge of Nature's laws, and of their application to our needs, which the world now possesses, thanks to the work of those great men, past and present, who have devoted themselves to the cause of science, and for the result of whose labours the world cannot be too thankful, still, what Newton calls "the vast ocean of truth" lies practically unexplored around us. Every item of knowledge we obtain only shows us how much there is to know; and, while many departments of human life and interest may always remain beyond the power of man to fathom, the possibilities disclosed by recent discoveries are such as to suggest that the future may have in store discoveries still more startling and brilliant, in the light of which our knowledge of to-day will appear but pale and dim in the eyes of posterity.

Section A.

ASTRONOMY, MATHEMATICS, PHYSICS, AND MECHANICS.

Address by the President,

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Fifty years ago it was shown by Sir William Thomson that there existed between the theory of electrostatics, at that time in its infancy, and the theory of the conduction of heat, then fresh from Fourier's hands, a very close analogy. So exact was the analogy that the solution of any problem in the one theory was at the same time the solution of a problem in the other: it was only necessary to change the meanings of the mathematical symbols. Some time afterwards Sir William Thomson, enlarging his former statement, showed that the analogy extended also to the theories of magnetism and of the irrotational motion of a perfect liquid through a porous solid. To these may be added the theory of the steady flow of electricity through conductors.

Nor is this list yet complete, for there may be added certain other theories, to some extent imaginary, yet important in that they are simple to realise, and therefore of great use in presenting to the mind an easy means of grasping the problems of their more difficult analogues.

It is a matter of the greatest interest that there should exist so wide and so perfect an analogy between these different branches of Physics: and for this reason alone I feel that I should be justified in making the analogy the subject of my address to you this morning. But I have also other reasons than that of inviting you to consider a curious mathematical correlation between several theories. It is, I think, of the greatest assistance to the student of Physics to follow up the analogy, and examine carefully its nature. It is a common remark that analogies are dangerous things, and the remark is often true enough. But the danger lies only in an imperfect knowledge of the extent to which reliance may be

made upon the analogy, and can be avoided once and for all by mending the imperfection. Moreover, the student of the theories of electricity and magnetism can hardly avoid the use of some sort of analogy, for these theories deal with the quantitative relations between quantities of whose real nature we are completely ignorant, and most minds cannot for long consider these relations in mere symbols, but must finally give them some sort of form.

Of all these theories, then, each is the analogue of any other. Each is founded on laws which have the same mathematical expression; each must be capable of similar development. The solutions of particular problems in any one theory must, *mutatis mutandis*, be solutions of corresponding problems in all the others. Not until by-laws peculiar to any one theory are introduced will the analogy break down.

Let me begin by stating briefly the fundamental laws and the mode of development of some one of these theories; it will be convenient to take as our first example that of the uniform motion of heat in a solid, as it is easy to form a mental picture of it. Then passing on to the other theories I will try to make clear the nature of the analogy, and the extent to which it holds good.

Imagine, then, a solid body in which heat is in motion in any uniform manner—uniform, in that the nature of the motion does not alter with time. The conductivity of the body may, in the most general case, vary from point to point, or even be different in different directions at the same point. There may be various places in the body where heat is being continually supplied, others where it is being continually abstracted; in other words, there may be sources positive or negative. All boundaries, internal or external, of the body may with advantage be considered as sources.

Suppose that we are supplied with information as to the conductivity of the body in all parts, as to the position and extent of its boundaries or sources. Suppose that we are also told either the temperature at each unit of area of boundary, or the rate at which heat is flowing across it; if, however, over any bounding surface closed in itself the temperature is known to be constant, it will be sufficient to know this temperature or the total flow across the surface. We can then solve the problem; that is to say, we can write down equations whose solution would tell us the temperature at every point of the body, or, if we like to express it so, the rate and direction of the flow of heat at every point.

It is easy to see, however, that in general the solution of these equations must be exceedingly complicated—that it is only in special cases that they can be solved at all. For example, our sources must be spheres or ellipsoids, or plates, or other simple surfaces. Our body must not be very irregular; if its conductivity varies in different parts and in different directions it must vary in some simple manner; some spherical portion, perhaps, may be of different conductivity to the rest.

But though we cannot, except in a few simple cases, solve the problem completely, we can obtain some general results which are of great importance, and practically almost as useful as a complete solution would be.

If we follow from its source the course of some small quantity of heat, our path is called a line of flow. By imagining these lines of flow to be drawn in all parts of the body we can form a complete mental picture of what is going on. If all the lines of flow which pass through the contour of some small area be supposed drawn, there is formed a tube along which heat flows as water in a pipe. No heat ever crosses the walls of the tube, so that if a section of the tube be made at any place, the area of the section multiplied by the rate of flow at right angles to the section is constant all along the tube. This constant is called the "flux" along the tube. Each tube must then start at some positive source and end at some negative source, or else lose its contents in the sands of infinity. If the conductivity of the body change suddenly at any point of the tube of flow, the tube will be bent more or less at the surface of separation, but the flux along the tube must always remain the same. Further, the size of each tube may be so adjusted that the flow of heat across any cross section is at the rate of one unit of heat per second.

By drawing tubes of flow in this manner it is possible to exhibit diagramatically the results of the solution of the equations in any particular case; and even when we cannot solve the equations we can often make a very good guess as to how the tubes will go, and so obtain a result near enough for practical purposes.

To put the matter in a mathematical and terser form, let us use the symbol V to denote the temperature at any point, c the conductivity at any point, and C the flow of heat across a unit area round any point. All these quantities are in the general case functions of the co-ordinates x, y, z; C and c are also functions of direction, but in most practical cases c is

a constant over large parts or regions of the body, and varies only from region to region. The three quantities are connected by the equation $C_s = - c_1 \frac{dV}{ds}$ where C_s is the flow in the direction s, $\frac{dV}{ds}$ the variation of V in this direction, and c the conductivity.

The data of the problem are—

(1.) The value of c in all parts of the body.

(2.) *Either* the value of the temperature at each point of the bounding surfaces of the body, *or* the rate of flow of heat across the boundary at this point: *i.e.*, the value at all points of the boundary of either V or $c \frac{dV}{du}$. If, however, V be constant over any bounding surface, it will be sufficient to know this value of V or the surface integral of $c \frac{dV}{du}$ across the surface.

Further, the fact that a state of steady flow has been attained is expressed mathematically by the equation $\frac{d\,Cx}{du} + \frac{d\,Cy}{dy} + \frac{d\,C_2}{d^2} = 0$ or $\nabla^2 V = 0$: an equation obtained by expressing the fact that in each second as much heat leaves any small volume as enters it. Also at every point of a surface separating from one another portions of the medium of different conductivities c and c_2, the flow of heat towards the surface on one side is equal to the flow away from it on the other: that is, $c_1 \frac{dV}{du^1} + c_2 \frac{dV}{du_2} = 0.$

These are the data: equations can now be written down whose solution would give the value of V (or c) at every point of the body, and this would constitute the complete solution of the problem. Diagrams showing accurately the solution of various comparatively simple cases have been drawn. Maxwell, for example, has drawn in his Electricity and Magnetism cases of two and three circular sources in an infinite and uniform solid; and Thomson has given in his papers diagrams of the flow of heat in a solid, whose conductivity would be uniform but for the presence of a spherical portion whose conductivity is different to that of the rest of the body.

Now let us turn to the theory of electrostatics. Here, in the most general case we have an insulating medium containing

conductors charged with electricity positive or negative. The potential at any point being denoted by V, the electric displacement by $\mathbf{D}$, the specific inductive capacity by K, we have always the equation $\mathbf{D} = \frac{K}{4\pi} \cdot \frac{dV}{ds}$, where K, as in the heat problem, is usually independent of direction. The value of $\mathbf{D}$ at any point of the boundaries of the body is otherwise spoken of as the surface density of electricity at that point. The data of the problem are:—

(1.) The value of K in all parts of the body.

(2.) The value at every point of the boundaries of either V or $K \frac{dV}{du}$: if, however, over any bounding surface V is constant, it is enough to know this value of V, or the surface integral of $K \frac{dV}{du}$ over the surface.

Further, we have the conditions that $\nabla^2 V = 0$, and that at any surface separating from one another portions of the body of different specific inductive capacities,

$$\frac{K_1}{4\pi} \cdot \frac{dV}{du} + \frac{K_2}{4\pi} \cdot \frac{dV}{du_2} = 0.$$

The problem is then exactly the same as the former one, and the results and diagrams spoken of before admit of a new interpretation. Sources or sinks of heat become positively or negatively charged bodies. Lines of flow of heat become tubes of flux of electric displacement. One end of each tube is on a conductor, the other end at infinity, or on another conductor. In any case the charges at the ends of a tube are equal and opposite, and so on. I need not enumerate any more of the details of the analogy. It is interesting to notice that one theory involves the idea of time, the other does not.

Of course it is not usual to found the theory of electrostatics on these data. It is usual to start, as Maxwell did, with the law of attraction between electrified particles. The development of the theory from this law leads naturally to the expressions involving potential and displacement or density. Then the student is suddenly aware that he is using mathematical expressions, which would have been obtained at once from the consideration of a continuous action taking place in the dielectric, instead of being the result of a lengthy development from the theory of action at a distance.

From the theory of electrostatics to that of magnetism is a very easy step. Each is founded on exactly similar laws, and the results must in the two cases be similar. Here we have a magnetic potential Ω and a magnetic force $\frac{d\Omega}{ds}$, usually called **H**: we have a "magnetic inductive capacity," more often called "permeability," and denoted by the symbol μ, and a "magnetic displacement" $\frac{\mathbf{B}}{4\pi}$: **B** is generally called the magnetic induction. These three quantities are connected by the law (analogous to that of electrostatics) $\frac{\mathbf{B}}{4\pi} = \frac{\mu}{4\pi} \cdot \frac{d\Omega}{ds}$ or $\mathbf{B} = \mu \mathbf{H}$. Word for word the general problem of magnetism and its particular solutions may be copied from those of electrostatics, if only we substitute for **D**, K, and E $\left(\text{or } \frac{dV}{ds}\right)$ the symbols $\frac{\mathbf{B}}{4\pi}$, μ, and **H**. The general problem is then the same in the two cases. But there are modifying circumstances which render the particular cases different in the two theories. In electrostatics the quantity K varies only in magnitude between certain narrow limits. In those media where it is highest it is only two or three times the value it has in those media in which it is lowest. It is true we may look upon conductors as parts of the medium in which K is infinite, but we may also consider them as bounding surfaces over which V is always constant. Strictly speaking this is the proper method to take, because a conductor is not a medium in which K is carried to an extreme, an infinite value, but a medium possessing a new property, that of conductivity. Glass, for example, possesses both properties, has two constants, one of specific inductive capacity, another of conductivity. In magnetism the range of μ is much greater. In iron, for example, it may be thousands of times as great as in air. In magnetism, too, there is no parallel to the conductor in electricity. The surface integral of **B** over any closed surface is always zero. We may, in fact, consider our medium to extend through all space. There is no need to partition off certain portions of space by boundaries. But we must remember also that in certain bodies μ is variable. It depends (1) on the value **B** has at the time, (2) on the value **B** has had in former times, *i.e.*, on the substance's retentiveness. This last peculiarity renders possible the existence of lines of induction, which return into

themselves, and form closed curves, as, for example, in the case of a bar magnet. There is also one other way in which these closed curves may be made, *i.e.*, by electric currents, which, running round a certain area, are able, by a sort of sideways action, to cause induction through the area. I think that when we come to consider the " strain " analogy we shall find that it will then be possible to picture these things very easily.

Meanwhile let me consider for a moment two more of our analagous theories.

One of these is that of the steady flow of electricity. In this the sources of heat in the heat problem become sources of electricity : the medium is a conductor of electricity, and we have everywhere the equation C (current) = — c (conductivity) $\times \frac{dV}{ds}$, where V represents electric potential. The data are :—

(1) The value of c in all parts of the body ;

(2) The value of V or of C at all parts of the boundaries. If, however, the value of V be the same over any boundary, it will be enough to know this value of V or the average value of C over the surface.

The condition $\nabla^2 V = 0$ holds good : also $C_1 = C_2$ or $c_1 \frac{dV}{ds_1} + c_2 \frac{dV}{ds_2} = 0$ at any point of a surface separating a medium of conductivity c_1 from one of conductivity c_2.

This is of course, in principle, the same problem as before. The main difference of detail is that c varies between such wide limits. The conductivity of copper is enormously greater than that of air. Let us take an example which will illustrate the analogy and yet bring out the points of difference. Imagine a long bar of copper joining two sources of electricity, one positive, one negative, the air being the surrounding medium. The lines of flow of electricity will be practically straight along the bar. If a bar of soft iron join two sources of magnetic displacement, the lines of induction will be very nearly along the bar ; but some will leave it, and, making a curved detour through the air, return to the iron again. Lastly, if the bar be made of ebonite and the sources be sources of electric displacement, the presence of the bar will not much affect the shape of the lines.

The hydrokinetic analogue, which I shall take next, is due to Sir William Thomson. Imagine a porous solid, and an incompressible frictionless fluid flowing through the solid in

irrotational motion. The porosity is not the same everywhere. Take as standard substances one in which the amount of fluid that fills its pores is of unit mass, the porosity being independent of direction. Then, in a substance whose porosity or "permeability" is μ, the mass of fluid filling unit volume is μ. If the velocity of the fluid be v, then v is a differential of a velocity potential Ω and is equal to $-\dfrac{d\,\Omega}{d\,s}$: this follows from the fact that the motion is irrotational. There will be lines and tubes of flow: along any tube, even if it cross a boundary between two parts of the solid in which μ is different, the amount of flow across any section is constant, *i.e.*, the flux of μv is constant: for μv is the amount that crosses unit area per second. Also, since the fluid is incompressible, $\nabla^2\,\Omega = 0$. If, further, we suppose that there are fixed in the fluid certain sources of liquid, positive or negative, of whose nature we have information, like that which we had of the sources in the other theories, it is evident that we have the same mathematical problem as before. In some of its details this analogue resembles very closely the theory of magnetism; and it was on this account that Sir William Thomson examined it. For, if we drop the somewhat unnatural idea of sources and sinks of fluid, and suppose that the whole of space is under consideration, liquid being free to move through every part of it, more or less, according to the value of μ, then we have the exact analogue of the magnetic field due to electric currents, the velocity at any point being the analogue of the magnetic force.

It is difficult, however, to represent hysteresis by this analogy. Take a simple case: consider a current running round a single loop of wire. The analogue of this is a motion of the fluid through the loop, round the outside, and back again, the velocity potential of the motion being equal to $4\,\pi\times$ current. If there be a lump of iron near, the velocity potential will be just the same, but the lines of flow will be altered in number and position. Now, if in the magnetic problem an equal and opposite current be started the field will not wholly cease to exist: there will still remain a field, due to the magnetism retained in the iron. In the other case—the hydrokinetic analogue—if an equal and opposite velocity potential be started into existence, it will destroy the motion altogether. Consequently we cannot, at any rate with a frictionless fluid, represent any of the effects of permanent magnetism. And, again, it does not seem

possible to get anything to correspond to the variation of μ with the amount of the magnetic induction.

Now I come to another class of theories, analogues of the foregoing—creatures of the imagination merely, but useful in that they furnish us with a simple and easily conceived picture of the other real theories. The simplest is that in which we picture to ourselves a certain medium of peculiar character. It is a frictionless incompressible liquid, and, unlike any known liquid, each unit of volume of it is so tethered to its position in space that if it be displaced a force of restitution is called into play proportional to the displacement. The imagery is curious, but simple enough to think of. It is easy to see that in such a medium the displacement d at any point is equal to $-\frac{1}{E} \times \frac{d\,P}{d\,s}$, where P is the pressure at that point, and E is the elasticity per unit volume. So d corresponds to electric or magnetic displacement, E corresponds to $\frac{4\,\pi}{K}$ or $\frac{4\,\pi}{\mu}$, and P to electric or magnetic potentials (V or Ω). The differential $\frac{d\,P}{d\,s}$ corresponds, of course, to $\mathbf{E}$ or $\mathbf{H}$. Since the medium is incompressible, we have $\Delta^2\,P = 0$: and at any surface separating from one another, parts of the medium of different elasticities d on one side$=d$ on the other side, or $\frac{1}{E_1} \cdot \frac{d\,P}{d\,u_1} + \frac{1}{E_2} \cdot \frac{d\,P}{d\,u_2} = 0$. Boundary conditions like those of the other theories may be supposed to exist here also: we may suppose P or d known at every point of the boundaries. If, however, we know that P is constant over any bounding surface, it is sufficient to know this value of P or the average value of d.

Here, then, is the same mathematical problem as before; and we have in this "strain theory" an exact analogue of the electric and magnetic theories, so far as the data just written down apply to the theories in common. Even the peculiarities of these theories are capable of simple representation. Hysteresis, we may consider, as caused by a certain friction in the displacement of the medium, so that the displacement under force may be hastened by vibration, and the removal of the force does not necessitate the undoing of the strain. In just the same way, tapping a tilted board will hasten the descent of a block resting upon it, or hasten the ascent if the block is under a force tending to raise it. Also, we may

picture to ourselves the decrease of μ with induction as an increase of E with displacement, a phenomenon common enough.

Again, in comparing the strain theory with that of electrostatics, we may represent a conductor as a part of the medium in which $E = 0$; or in which the medium is not "tethered" at all, but able to move freely. In a paper I had the honor to present to this Section last year, I worked out the analogy with the theory of electrostatics. The development is particularly simple—much simpler than it is on the ordinary theory.

It must always be remembered that this is only an analogy, not a theory. It was first suggested by Maxwell; but I do not think it has since received the attention it deserves. There is no analogy which gives such a clear picture of the relations between electric quantities considered by themselves, and magnetic quantities considered by themselves, a picture of which we stand very much in want at the present day. So far as it goes the analogy is complete—it is almost a theory; it only breaks down when we come to the relation between variation of magnetic induction and electro-motive force caused thereby. It is, too, a decidedly good point in this analogy, that it throws into prominence just those quantities which are in constant use in modern work in magnetism. The permeability μ is represented by $\frac{4\ \pi}{E}$; in iron, for example, the elasticity is very small, it yields very easily to magnetising force. $\mathbf{B}$ the magnetic induction is $4\ \pi\ \times$ displacement. Lastly, the magneto-motive force Ω, whose line variation is called $\mathbf{H}$, is the pressure. On the other hand, the analogy does not so readily give a physical representation of the less used quantities I and K, quantities which are indeed superfluous if we use μ, $\mathbf{B}$, and Ω. To see what is the analogue of I we must proceed in this way:

Consider a small volume within a mass of iron. Let $\mathbf{B}$ be the induction there, $\mathbf{H}$ the line variation of Ω or the magnetic force, μ the permeability of the iron, and μ' that of the air or other surrounding medium. Then I is defined by the following relation:—

$$\mu\,\mathbf{H} = \mathbf{B} = \mu'\,\mathrm{H} + 4\pi\,\mathrm{I}$$

$$\therefore \mathrm{I} = \frac{\mu - \mu'}{4\pi}\,\mathbf{H}$$

or, I is the induction that would be necessary to cause a force **H** (*i.e.*, a variation in the magneto-motive force of **H** per unit length) in a medium of permeability $\frac{\mu - \mu'}{4\pi}$. The magnetic susceptibility K is simply $\frac{\mu - \mu'}{4\pi}$. Both these quantities I and K depend, therefore, on the permeability of the surrounding medium as well as on that of the iron, and cannot properly be said to belong to the iron.

I should like here to suggest that in future **B** and **H** be never treated as of like dimensions; that the equation $\mathbf{B} = \mathbf{H} + 4\pi\,\mathrm{I}$, if it is ever necessary that it should be written at all, should be written $\mathbf{B} = \mu'\,\mathbf{H} + 4\pi\,\mathbf{I}$, μ' being the permeability of the air, or, in other words, we should make μ the absolute, not the specific, permeability of a substance. As for the equation itself, it is most interesting historically, but it is not necessary to the development of the theory. What would be thought of us if we wrote:—Weight of a substance = its volume + 4π × something to make this equation a correct one? And the statement is not much bettered by substituting for "its volume" the words "weight of an equal volume of water."

The analogy, being correct, gives a true value of the energy of a magnetised medium. The energy per unit volume in the analogy is $\frac{1}{2}\,\mathrm{E}\,d^2$, which (translating)

$$= \frac{1}{2}\,\frac{4\pi}{\mu}\cdot\left(\frac{\mathbf{B}}{4\pi}\right)^2$$

$$= \frac{1}{8\pi}\cdot\frac{\mathbf{B}^2}{\mu} \text{ or } \frac{1}{8\pi}\cdot\mu\,\mathbf{H}^2 \text{ or } \frac{1}{8\pi}\cdot\mathbf{B}\,\mathbf{H}.$$

It is easy to picture by this analogy the events that take place when a circuit carrying a current, or a permanent magnetic shell, attracts a piece of iron. Suppose a plane circular shell, uniformly and permanently magnetised, to be immersed in a medium of permeability μ', and a piece of iron of permeability μ to be in the neighbourhood. We know then that the magnet will attract the iron, the energy of the field diminishing as the two approach, for the permanent magnet gives rise to so much induction, as the iron approaches the magnet it takes up a larger share of the total induction. But the energy of so much induction in iron is much less than in air, for energy per unit volume is $\frac{1}{8\pi}\cdot\frac{\mathbf{B}^2}{\mu}$. On the other

hand, if we replace the magnet by a circular current we know that the opposite effect takes place. The current still attracts the iron, but as the iron approaches the circuit the energy of the field increases, for the nearer the iron is to the circuit the greater is the amount of induction produced by the constant magneto-motive force of the current; consequently, the greater is the volume integral of $\frac{1}{8\pi} \cdot \mathbf{B}\ \mathbf{H}$, *i.e.*, the energy of the field.

Now, this is very well represented by the analogy. Instead of the magnetic shell or the current round its contour, imagine a thin plane membrane placed in an elastic medium. Apply a uniform pressure all over one side of this membrane, it is displaced, and lines of displacement spring into existence, starting at one side of the membrane and curving round to the other. This gives us the analogue of the field due to a circular current, and the quantities are so related that pressure per unit area corresponds to $4\pi \times$ current. The amount of the displacement will depend on circumstances—on the nature of the bodies in the field, their positions and elasticities. Even if the medium be uniform the displacement of the various parts of the membrane will not all be uniform, but will be greater near the edges than in the middle. To get the analogue of a magnetic shell we must suppose the membrane moved just as a uniform pressure would move it in a uniform medium and then fixed.

Now, in the former case, where the pressure is constant, if part of the medium near the membrane be weakened (iron be brought near it), the energy of the field will be increased, but, in the latter case, where the displacement is constant, the energy will be diminished. Just so the energy of a spring stretched by a given force is increased if any part of the spring is weakened, but if it be stretched a given amount the energy is by the same cause diminished.

A curious mistake is often made with regard to the nature of magnetic shells. It is supposed that they can be built up of numbers of small similar magnets placed side by side, so as to have all their N. poles adjoining one another, and so making up one face of the shell, all the S. poles making up the other face. But the result of such a combination, according to the most natural interpretation, would be to cause lines of induction to start uniformly from the shell-face, so many lines per unit of area. This would not at all resemble the effect of a current, which causes more induction

near the contour than in the middle. In fact, it is quite the wrong idea: what is meant by the shell is a pair of parallel uniform sheets of magnetism—one N., the other S.—placed at a certain distance apart, and having *air*, not iron, in between them. It is to this case that the mathematics of shells applies, and to this alone. The magnetic shell is the exact analogue of the plate-condenser in electrostatics, the plates bearing equal and opposite charges. The magnetic field of a shell corresponds to such part of the electrostatic field of the plate-condensers as lies outside the plates, and not between them, the part which, in the electrostatic problem, is not the important thing, but the correction. The strength of the shell is the amount of magnetism per unit area of either sheet multiplied by the distance between the sheets, and is no measure of the actual magnetisation of a real shell which would produce the same effect. So also the moment of a magnet is the product of either of two equal amounts of magnetism—one negative, one positive—placed a certain distance apart in *air*, and of this distance, and has nothing to do with the actual magnetisation of the magnet whose effect is defined by its aid.

When a current runs round a circuit and produces a magnetic field in the neighbouring medium, we may consider the effect as that of a magnetomotive force acting upon a magnetic circuit and producing a magnetic displacement along the circuit. If the medium about the current be uniform and of permeability μ, then a given current C acts with a magnetomotive force 4π C, and the total induction through the circuit is L C, where L is called the co-efficient of self-induction of the circuit. We may realise this by turning to our analogy for a moment. We have a uniform pressure $4\pi C$ acting upon our membrane: the membrane is displaced so as to move through or generate a volume proportioned to C, say equal to $\frac{LC}{4\pi}$. Hence the energy stored up in the medium is equal to $\frac{1}{2}.4\pi C.\frac{LC}{4\pi}$, or $\frac{1}{2}LC^2$.

Since a magnetomotive force equal to $4\pi C$ produces a total induction through the plane of the circuit of L C, we may look upon $\frac{L}{4\pi}$ as the "resistance" of the magnetic circuit.

In fact, if μ were constant at any particular point for all past and present values of **B**, the magnetic circuit would be strictly analogous to the electric one.

As an example, let us take the sinple case of an anchor-ring coil of length l. All the opposition to the magneto-motive force will come from the medium within the coil. Hence, if A be its area of section, d the displacement along it, E the elasticity, then, reasoning from the analogy, we have—

$$A \times \text{pressure} = l.A.d.E\,;$$

or, translating,

$$4\pi.C = l.\frac{4\pi}{\mu}.\frac{B}{4\pi}.$$

Hence the total induction $= A.\mathbf{B} = \dfrac{4\pi C}{\dfrac{l}{\mu A.}}$

Thus the "resistance" of the circuit is equal to $\dfrac{l}{\mu A.}$

The energy in the case of an anchor-ring coil wound with n turns to the centimetre is plainly—reasoning from the analogy—

$$\tfrac{1}{2} A \times \text{pressure} \times d.$$

But $4\pi C.ln A = l.A.d.E$

$$\therefore d = \frac{4\pi C.n}{E}$$

Hence, substituting, the energy

$$= \frac{1}{2} A.4\pi C.l.n.\frac{4\pi C.n}{E}$$

$$= 2\pi A.l.n^2 \mu.C^2$$

the well-known formula.

I will just give one more example of the use of the analogy. Consider the following problem, as it has been several times stated.

If a diamagnetic substance be made to approach a magnet, moving from a position A to a position B, work will have to be done: suppose the diamagnetic substance to possess, as it may do, some small amount of retentiveness, then a slight tap, involving an infinitesimal expenditure of work, will cause tho diamagnetism, and therefore the repulsive force to increase. If now the substance be withdrawn to its former position and again slightly tapped, the substance will have gone through a complete cycle, and there has been a nett gain of energy. This is an absurd result; and the flaw in the reasoning occurs in the assumption that the first slight tap will increase the diamagnetism: it will, of course, diminish it. All this is very easy to picture by the analogy. A diamagnetic sub-

stance is simply one in which E is greater than in air. When the substance is brought from A to B the lines from the magnet avoid the substance, as it were, for displacements in it are difficult of production. A little tap will help the displacements to be made: the displacements become more nearly what they would be if the substance were not there, and so the diamagnetic effect is lessened. Consequently, on the withdrawals of the bismuth from the magnet the force of repulsion is less than on its approach, and there is no violation of the principle of conservation of energy.

It is interesting to notice that if there is any retentiveness in bismuth the effect of a magnetising coil will be to produce magnetism, so to speak, not diamagnetism. The bismuth will be magnetised in the same way in which a piece of iron would be under similar circumstances, only, of course, to a far less degree. For, thinking of the problem in the strain analogy, the particles of the bismuth are not displaced in a direction opposite to that of the displacing force; they are displaced in the *same* direction, but less than those of the majority of substances would be.

I have described this strain analogy somewhat at length: it is not the only one of its class, but I will not say more than a word or two about its fellow members.

If we replace the displacement of translation of the theory just discussed by displacement of rotation, we have a new analogue of electric and magnetic theories. Here the strain is one of torsion: we must suppose the particles of the medium to be twisted from their natural set, and forces of restitution to be called into play proportional to the amount of twist. The proportion between strain and stress will be different in different parts of the medium. There will be lines and tubes of twist, and along any tube the amount of twist is handed on unchanged. This theory represents the phenomena of electricity and magnetism just as well as the displacement theory, but it is more difficult to realise.

Again, we may replace displacement by "spin," and obtain a kinetic analogue: amount of displacement must be replaced by rate of spin, force of restitution per unit volume by momentum per unit volume, elasticity per unit volume by moment of inertia per unit volume. Energy per unit volume will, of course, be $\frac{1}{2}$ momentum $\times$ rate of spin. On this analogy the particles of iron possess much less inertia than those of other substances.

There will be lines and tubes of spin; and along any tube the amount of spin will be handed on unchanged.

Or we may employ a sort of inverse of the preceding analogy. We may substitute for displacement momentum per unit volume, and for force of restitution rate of spin. Then elasticity must be replaced by the reciprocal of moment of inertia; and so in iron the particles must be thought of as possessing much moment of inertia. This analogy has been used by Dr. Lodge, as giving some idea of the way in which electromagnetic waves are propagated. He supposes the $\frac{1}{K}$ of a medium to be its elasticity, and μ to be its density, so that the velocity of waves will be $\frac{1}{\sqrt{K\mu}}$. We have in this analogy to suppose that there are lines and tubes of spin, and that along a tube of spin the momentum of the spinning matter between two sections of the tube, a small and constant distance apart, is uniform along the tube.

In this table of analogues I have grouped the main facts which we have been considering:—

TABLE OF ANALOGUES.

Displacement Theory	P (pressure)	d (displacement)	E (Elasticity)
Heat	V Temperature	C Flow of heat	$\frac{1}{c}\left(\frac{1}{\text{conductivity}}\right)$
Electrostatics	V (Potential)	D (electric displacement or surface density)	$\frac{4\pi}{K}\left(\frac{4\pi}{\text{specific inductive capacity}}\right)$
Current Electricity	**E** (line integral of electromotive force)	C (current)	$\frac{1}{c}\left(\frac{1}{\text{conductivity}}\right)$
Magnetism	Ω (magnetic potential)	$\frac{\mathbf{B}}{4\pi}$ $\left(\frac{\text{induction}}{4\pi}\right)$	$\frac{4\pi}{\mu}\left(\frac{4\pi}{\text{permeability}}\right)$

Hydrokinetics	Velocity potential	momentum per unit volume	$\frac{1}{\text{permeability}}$
Twist	Line integral of twisting stress	Torsion	torsional elasticity
Spin (1)	Line integral of momentum of spin	Spin per unit volume	moment of inertia per unit volume
Spin (2)	Line integral of rate of spin	Momentum of spin per unit volume	$\frac{1}{\text{moment of inertia per unit volume}}$

In the displacement theory, $d = -E\,\frac{dP}{dS}$ and $\nabla^2 P = 0$.

Similar laws hold of the anologues of d, E, and P.

And now I have ended the task which I set myself. I have tried to show briefly the extent of the analogy between all these different theories. I believe it is most important that every physical student should examine this analogy, because in doing so he looks at each theory from many points of view, and, even more, because he learns to substitute in all the theories the idea of continuous action through some medium for that of action at a distance. The tendency of modern work is always to make this substitution: no better example can be found than the growing use of the idea of the magnetic circuit. It is as though—I am supposing that even now you are not quite tired of analogies—the pioneers of electricity had slowly and painfully made their way, by tortuous paths, through country new and difficult. We, following in their footsteps, and learning to know the country they rendered accessible, have found that by starting from a somewhat different base we may attain the same ends by straighter and plainer roads. With these new roads it is our duty to become familiar. We shall be rewarded for our pains by finding ourselves able to make a fresh start—a further advance into regions as yet unknown.

Section B.

CHEMISTRY AND MINERALOGY.

Address by the President,

WILLIAM M. HAMLET, F.I.C., F.C.S.,

Government Analyst, N.S.W.

When I became aware of the honour conferred upon me in being elected to the presidency of this Section, the question arose in my mind as to what the scope and character of the time-honoured Presidential Address ought to be. Should we bring before us the old platitudes and mystic half-truths embodied in the obsolete theories of the past, or, on the contrary, should we not try to obtain a clear presentment of recent advances in the science? and to recognise, in fact, the real benefits conferred upon the race by our increased knowledge; to recognise that the advance onward is always towards raising and bettering the lives of those around us, to finally become the heritage of those who follow us in the chain of life. Nor is it the only function of a President to convey to his hearers the *résumé* of the year's work; this may be better done by the numerous and increasingly-bulky year-books. Who amongst us does not remember the revered name of many a President of the older Association in Britain who presented the everyday facts of our science in such a clear and attractive manner that we thought no more of the toil and the unyielding patience required in our work, but only of the high aims and possibilities, of the ultimate unity and full relationship of all natural knowledge. This sense sublime—

> "Of something far more deeply interfused,
> Whose dwelling is the light of setting suns,
> And the round ocean and the living air,
> And the blue sky, and in the mind of man:
> A motion and a spirit, that impels
> All thinking things, all objects of all thought,
> And rolls through all things"—

was in no small degree fostered by such annual addresses. How many of our past Presidents have there not been who

seemed to act as the sign-post pointing to the Elysian fields of new researches,—who, by their help, counsel, and encouragement, inspired the earnest labourer in the pursuit of truth, and led him on to new discoveries?

The progress of Chemistry and Mineralogy in Australasia, upon which it is my privilege to address you to-day, is, from the nature of the circumstances, slow and beset with many hindrances. And this chiefly because the greater portion of our energies are devoted to the estimation of the monetary value of the natural and commercial products around us.

Here, in this later-known part of our planet, we needs must spend a great deal of our time in work that can only advance science somewhat indirectly; so that it might be said that the record of the year with regard to original research-work, were it given in its entirety, would read very much like Falstaff's hotel-bill, showing but a halfpennyworth of research to an intolerable deal of drudgery. This, I admit, must necessarily be the case with most of us in a new country, who, if not engaged in teaching and organisation, are compelled to spend our time in assaying minerals, or else in the pursuit of the agricultural, sanitary, or criminal investigations incidental to our rapidly-growing centres of population. Chemists in Australia occupy places in the rear-guard of the advancing army of science; and while it may not be our fortune to be at the outposts skirmishing on the frontier of the knowable, yet we have daily-recurring duties that are none the less necessary for the wellbeing of society: thus, at least, we may presume to say that we indirectly help forward the general advancement of science.

Still, some work has been done during the year in spite of these drawbacks; and this includes the discovery of the alkaloids brucine and strychnine in the fruits of *Strychnos psilosperma*, by Professor Rennie and Mr. Goyder, of Adelaide, who find 0·32 per cent. of the mixed alkaloids in some specimens sent them by Baron von Müeller.

Additions to our knowledge of the Australian gums and barks have been made by Mr. J. H. Maiden, of Sydney; the first gum recorded from one of the Tiliaceæ, or Lindenblooms—a metarabic gum obtained from *Echinocarpus (Sloanea) Australis* has been examined, also the gum of the grass-tree and the resins in certain species of *Pittosporum* and *Araucaria*, while he finds the kinos of great aid in the diagnosis of the different eucalypts.

Conspicuous amongst Mr. Maiden's researches is his work

on Wattle-barks,* which are found to contain from 15 to 46 per cent. of tannic acid, and have already proved to be valuable for tanning purposes, and their cultivation found easily remunerative to the agriculturist.

Then may be mentioned Mr. Kirkland's discovery of gallium and indium in some specimens of blende from Peelwood, N.S.W., the details of which will form the subject of an interesting paper by Mr. Kirkland. The minute structure of several of our more important rocks and minerals is being carefully and thoroughly investigated by the Rev. J. Milne Curran, F.G.S., a gentleman who has lately been awarded the £25 prize and the medal of the Royal Society of New South Wales.

Not only is the presence of the rarer metals of interest, but it is satisfactory to note that some observers are making efforts to find out the actual state of combination in which elements occur. An instance of this has lately been mentioned to me by Mr. Atherton through Dr. Storer, who finds gold in the state of sulphide at Deep Creek, Nambucca, N.S.W. Quantities of the raw ore were treated with sodium sulphide, and the gold obtained as Au_2S_3, there being only the merest trace left unacted on.

Much of this kind of work needs to be done in the Colony; and if such questions were investigated by men who understand what they are doing it would go a long way towards facilitating the operations attempted in the smelting works, where carbonates, chlorides, oxides, and sulphides are often expected each to yield to the same kind of treatment.

Much has been said, and is still being said—though chiefly by speculators and mining-share manipulators—about the vast mineral resources of Australia, and glowing accounts are set forth (in the prospectus, be it observed) of reefs, leads, and auriferous deposits innumerable, where the precious metals are supposed to exist in most comfortable and payable quantities. But, when operations are well advanced, there comes the inevitable awakening, when plain facts clearly indicate that nature is not to be flirted with, notwithstanding the potency of a prospectus. Machinery rusting in idleness, useless furnaces, and other lumber remain as monuments of the unfortunate practice of erecting mining plant before the nature of the mine is sufficiently understood. The dearly-

* Wattles and Wattle-barks, by J. H. Maiden, F.L.S., F.C.S. *Second edition.* Sydney: The Government Printer, 1891.

bought lesson is this—that it is impossible for men who lack the necessary training in metallurgy to embark in adventures which, if attempted in other walks of life, would be considered madness. Yet the non-fulfilment of the expectations of those who invest in mining properties is ascribed to any cause but the right one.

The easy-going nugget-finding days are past, and have become a matter of history, while modern mining demands, more than ever, a larger share of skill, perseverance, and hard work. Smelting and reducing operations must necessarily become increasingly difficult as the richer ores become exhausted and new difficulties present themselves.

The problems of to-day are:—

1. Treatment of the so-called refractory ores.
2. Winning the precious metals from low-grade ores carrying but a few ounces to the ton.
3. The extraction of the metals from minerals holding some objectionable metal, or rather a metal that at present embarrasses the smelter—such, for instance, as the presence of zinc and sulphur in the Broken Hill ores.

To presume to deal with anything like a solution of these difficulties is quite beyond both my province and intention; but I would like to remind you of the sort of difficulty that blocks the way to success in many mines throughout Australia, and I moreover desire to point out some course of action that may probably be adopted in the near future (if I may make use of the expression) while social and labour difficulties stand like lions in the path whenever these problems are broached. However, come when it may, I foresee a time when other processes will supplant the expensive and crude methods hitherto attempted. Already there are companies and mine proprietors who perceive the want of processes better adapted to meet particular cases, and we hear a good deal about chlorination and wet methods for the separation of gold and silver.

The principle underlying all wet methods whatsoever is the chemical action of the electro-negative molecules, oxygen or chlorine, rightly and economically applied to suit the particular kind of ore to be treated.

Where sulphur is the *bête noir*, oxygen may be advantageously used if the metal be convertible into a soluble sulphate. Sulphur being absent, or easily removable by preliminary roasting, as in a great number of cases, then we

may bring into operation the vigorous action of the little chlorine molecule—an instance of the phenomenon of that subject of solution which is profoundly interesting the minds of the chemists of the present day.

Now, as the source of the world's chlorine supply is the common salt we see on our dinner-tables every day, this familiar and salutary article must become an object of absorbing interest. Strange as it may appear to many, it is hardly too much to say that the phenomenon presented to us of a spoonful of salt dissolving in a tumbler of water is under close observation and forms the subject of investigation of the best chemical philosophers of our age.

It may also seem a strange and far-fetched idea, yet the attention now bestowed on the physical and chemical properties of the molecule in solution must eventually contribute to the perfecting of new methods of separating metals from other elements with which they are associated in the ore. Leaving the practical side of the subject for a time, let us see what is being done in this interesting domain of molecular mechanics,—let us track the chlorine molecule into space.

He who surveys the ever-widening boundary of modern chemistry cannot fail to be impressed with the increasing amount of attention bestowed on physical and general chemistry. It would seem as though a reaction had set in: instead of the appalling host of carbon derivatives, which no man can number, endless as they seem in their protean permutations, we see a desire on all hands to know more of the varying phases of matter which were formerly passed by as trivial or commonplace; to picture the atom in space; to form clearer conceptions of the rushing together of atoms in the act of combination,—in a word, to know something more definitely about chemical action. Thus am I led on to the subject of the molecule *per se*—the free ion—the whirling, eddying, ether-embedded molecule.

Our present position finds us in possession of the well-established—may I not say, the impregnable—theory of an all-pervading ether describable as an elastic solid endowed with a great degree of rigidity. From the time of Young onwards this working hypothesis has commanded the assent of all thinking men, confirmed and strengthened as it is by the classic and firmly-founded work of Sir William Thomson, and others who have approached the subject from all sides.

Clearer perceptions also prevail with regard to the discontinuous or heterogeneous nature of matter even of those

solids which appear to our senses and to our most refined and delicate instruments as perfectly homogeneous: moreover, the kinetic theory, not only of gases, but of all states and conditions of matter, has received general recognition.

Yet another theory will, I am sure, commend itself to your earnest attention—one I have thought a good deal about for some years past, and which has been touched upon by Mendelejeff eighteen months ago when lecturing at the Royal Institution in England.

The idea may be considered a wild speculation by some; but I am bound to believe, judging by analogy with the magnificent conceptions presented to us by modern astronomy, and by the observed behaviour of matter as shown lately by the work and discoveries of Crookes, Thomson, Ostwald, Arrhenius, Van't Hoff, and many others, that, just as the systems of worlds, suns, stars, and planets roll in limitless space, so rolls the atom, but at enormously increased velocities in symmetrical order like double stars, or in systems comparable to suns and their accompanying satellites—the complete, self-existent, undissociated molecule being comparable to a given solar system coursing through space.

The work of Maxwell, Faraday, Helmholtz, Lodge, Fitzgerald, Hertz, and Sir William Thomson, men who, like Huxley's ideal possessor of a liberal education, can "spin the gossamers as well as forge the anchors of the mind," all contribute towards clearing up the mystery surrounding the thing daily handled and observed by the chemist—the familiar thing we call "matter."

Putting aside for the moment the idea as to whether the atoms are or are not portions of the ether differentiated off from the rest by reason of their vortex motion, we have in the omnipresent ether, at any rate, the space, the playground, for the atom, whose unseen but energetic movements we have learned to speak of as heat and chemical action.

Having, then, granted a place in the universe for the ubiquitous atom, the chemist must endeavour, however dimly it may be, to picture to his mind its relative position, its own proper motion, its translatory motion, and, above all, its influence upon the ether when rocked by the waves set up by vibrating masses of atoms at a distance. When this is known we shall be able perhaps to account for the specific differences presented to us by matter.

In its simplest aspect we may think of the substance of the

universe, at least of that which appeals to our senses, as consisting of what we arbitrarily call matter, and of its smallest portion as the indivisible atom—an idea held by ancient philosophers some three centuries before Christ; the smallest quantity assumed to exist freely in space under known conditions being the molecule. From what we have seen and from all we know of infinitely minute particles of matter, can we think or conceive that these molecules are huddled together like a chaotic heap of bricks? Assuredly not,—at least not in a definite compound; and the truth is borne in upon us at the thought of the microscopic yet symmetrical crystal. Looking about for a familiar and universally known substance, we have in water an instance of a symmetrical molecular system, whether under the form of solid ice, liquid water, or gaseous steam, made up of three atoms.

It will greatly assist us in our contemplation of the molecule if for the nonce we magnify these atoms several million times beyond their actual size. We should probably see a small sphere rotating about an axis, and at a given distance two larger spheres also rotating about their own axes, but travelling in a definite orbit around the smaller sphere, the three together forming a system revolving in one plane with its own individual precession, the whole system capable of moving at a great velocity in any possible direction.

Calling these individual planets in the molecule by their received names, we see oxygen as a central sun with two large primary planets both called hydrogen, situate at equal angular distances from each other, but with nothing known at present to distinguish either of the hydrogen planets from each other.

Suppose, now, their orbital velocity be caused to diminish by friction and to finally cease, we should have each hydrogen planet distant 180° from one another. Placing three such systems with no orbital motion over each other so that the hydrogen satellites shall be equi-distant, a straight line passing through and intersecting each of the centres of the oxygen spheres will form a hexagon.

Now, it is a fact that water in crystallizing to snow and ice assumes the form of the hexagon. May not this cessation of the orbital motion determine the act of crystallization, and on the other hand the widening and opening out of the orbit determine the expansion, while the friction of hydrogen against hydrogen satellite determines the heat caused by compression.

In trying to realise these things, I have asked you to magnify the dimensions of the atom in the structure of matter: this has already been done, as you well know, by Sir William Thomson; but, as a better estimate of the size of the atom will be gained, his calculation will, I think, bear repetition. "Imagine," he says, "a globe of water or glass, as large as a football,* to be magnified up to the size of the earth, each constituent molecule being magnified in the same proportion. The magnified structure would be more coarse-grained than a heap of small shot, but probably less coarse-grained than a heap of footballs."

A glassful of pure water, then, consists of an enormous, an unthinkable number of molecules, each consisting of a complete system of atoms arranged by law in a definite and determinate order, like the orbs we see

"In the sacred glory of the azure night."

It follows that in this mass of water there must be intra-molecular spaces, and that the molecules are everywhere throughout the liquid jostling, colliding, and sliding over one another. It also follows that, if we can communicate motion from without, the mere gliding of molecule over molecule will give way to sharp collision, impact succeeding impact until the crowd of molecules is in a state of great internal commotion. Such an effect is brought about by the mere application of heat, and the energy of this motion is capable of being accurately measured.

This internal bombardment of molecules may proceed further, until cohesion and surface tension is overcome and the gaseous state is arrived at.

Regarding matter as being thus constituted, what should happen when we throw a few grains of salt into water? Clearly, it must be that as soon as the molecules of sodium chloride come within range of the water molecules friction and collisions ensue, the nearest salt molecules being driven into intra-molecular space. The amount of heat necessary to undo the crystalline structure—in other words, the motion acquired by the sodium chloride on coming into solution—is abstracted from the water molecules; that is to say, work is done by the water molecules, hence a reduction of temperature in the liquid. Had we substituted potassium iodide with its greater molecular weight instead of the sodium chloride, the

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* Or, say a globe of 16 centimeters diameter.

reduction of temperature would be greater. The solution of a salt in water may be regarded as the removal of molecule after molecule in the crystalline architecture, the whole mass finally reaching one uniform state of motion—*i.e.*, equilibrium of temperature and action. The molecules thus dislodged from their recent crystalline structure are free to spin through the liquid as double stars, having a diminished degree of attraction for each other owing to their approximately similar atomic weight. Thus it comes to pass that we have a stage of incipient dissociation, a large proportion of the atoms being liberated in the free state or dissociated into their ions,—a conclusion arrived at by Arrhenius in 1887, and quite independently by Planck in the same year.

The apparent decomposition of a salt solution, *i.e.*, an electrolyte into free ions, is considered by some to be a process of direction and not one of real decomposition; but I think myself that it is one of oscillation between mere direction on the passage of the current on the one hand, and dissociation on the other.

In the present controversy between association and dissociation there is reason to believe the advocates of both systems to be right, so far as the facts are concerned, the phenomena presented by the hydration of sulphuric acid not being on all fours with the facts brought to light in cases of salt solution. However, the day will soon dawn when the whole subject relating to chemical energy will be fully elucidated, and means found for its precise measurement. It is now a veritable mine of intellectual activity, and it is no wonder that new facts are constantly being recorded.

We may expect that, with such an array of facts such as are now given to the world by Ostwald, Van't Hoff, Gladstone, Pickering, Arrhenius, Armstrong, and others—facts that slip easily into their proper places in the great fabric of Physical Science—that some master mind must sooner or later arise who shall so co-ordinate, interpret, and arrange them as to deduce therefrom the laws of chemical energy and affinity. Mendelejeff, in recognising this, bids us anticipate such a grand realisation. He says,* "the invisible world of chemical atoms is still waiting for the creator of chemical mechanics. For him our age is collecting a mass of materials, the inductions of well-digested facts, and many-

* An Attempt to apply to Chemistry one of the Principles of Newton's Natural Philosophy: a Lecture delivered at the Royal Institution of Great Britain, May 31, 1889.

sided inferences similar to those which existed for astronomy and mechanics in the days of Newton." It is well to remember that Newton devoted much time to chemical experiments, and while considering questions of celestial mechanics, persistently kept in view the mutual action of those infinitely small worlds which are concerned in chemical evolutions. For this reason, and also to maintain the unity of laws, it seems to me that we must, in the first instance, seek to harmonize the various phases of contemporary chemical theories with the immortal principles of the Newtonian natural philosophy, and so hasten the advent of true chemical mechanics.

As the avowed object of most of the addresses that are inflicted upon us should be "to point a moral: to adorn a tale," we ask ourselves, Is there no interest in this question of salt-solution for us here in Australia? I venture to believe there is. And thus we come back to the question of the action of solvents generally, and the practical application of them in what are called wet processes in mining and metallurgy.

The extraction of metals from their ores has been effected from time immemorial by the old well-known methods of smelting, the object generally aimed at being the separation of the metal in the molten state by the addition to the ore of some mineral or earthy substance to cause the mixture to fuse, flow, or flux while subjected to the great heat of a furnace, the metal separating out by itself in a more or less pure condition.

The cost of such a scheme of well-planned operations as these will, of course, vary with the degree of richness of the ores, the cost increasing with the poverty of the ore treated, a limit soon being reached which depends on local and other conditions, and the poor ores can only be regarded as so much useless rubbish that will not pay for smelting. In such cases a wet process for extracting the metals might be advantageously employed, and we may dissolve the precious metals in a watery solution and collect them by suitable means. To the miner who is unfamiliar with such a process it sounds an impossible and an uncanny way of doing things. However, several wet methods commend themselves to the metallurgist in cases where the ores are too poor to be worked economically by any other means.

Speaking generally, the end in view is to obtain the metals in a soluble form, either as chloride, sulphate, or cyanide, and

then to remove them from the liquid by precipitation. In this way we can separate out gold, copper, zinc, silver, and lead.

In the case of chlorination the sources of the active chlorine are :—

1. The decomposition of bleaching powder either by acids or acid sodium sulphate.
2. The direct use of the chlorine liberated by electrolysis.
3. Roasting the ore with salt.

The first of these methods is open to serious objection owing to the wasteful loss of chlorine, and the difficulty of transporting oil of vitriol over rough country. Both of the other methods have much to recommend them in a country like Australia.

Amongst the simplest processes suitable for Australian ores—one adapted for the extraction of silver from ores not rich enough to pay for smelting, or from ores that do not easily yield to ordinary treatment—is the Joachimsthal process suggested by the late Dr. Percy and Von Patera, also known as Kifs' method.

Many modifications and improvements have been made on the original process, and the names of Henderson, Claudet, and others are associated with it, the modifications being made to suit the great variety of ores treated.

The ore, broken small, dried, if necessary, and crushed fine under the stampers, is mixed, with or without preliminary roasting, according to the nature of the ore, with 12-15 per cent. of common salt, and roasted 6-10 hours. The active chlorine molecule seizes the copper, lead, gold, and silver molecules to form the chlorides of these metals. On now soaking out the cooled product in water—the operation termed leaching—a portion of the now soluble metals are removed, being dissolved in the salt water. Allowing the earthy impurities to separate, this liquid is drawn off and set aside for after treatment. The roasted ore is further lixiviated by means of a cold solution of 1-2 per cent. sodium thiosulphate, and added to the first liquor. From this the lead is removed as "white lead" by soda ash, yielding at once an article of commercial value, and the copper and silver are both separated out by precipitation with sodium or calcium sulphide; the product, containing 25 per cent. of silver, is dried and roasted, being then available as a marketable commodity. This process has been successfully carried out at Rivertree, N.S.W., by Mr. Hall, of

Brisbane, who finds that 85 per cent. of the silver present in low grade ores may be obtained in this way.

Another process lately brought into use in Queensland and in Victoria is the "Pollok Chlorination Process," more especially adapted for gold ores. Chlorine under great pressure is employed to dissolve the metal, the gold being separated by an iron salt. The details of this process is given by the late C. S. Wilkinson, who inspected its working while in Glasgow about a year ago.* Mr. Wilkinson also described the Macarthur-Forrest cyanide process, in which a weak solution of potassium cyanide is used to dissolve out the precious metal, which is then removed by metallic zinc. The process is being worked at Ravenswood, in Queensland.

The chief considerations that have to be taken into account in any of these methods of working must necessarily include the question of easy transport across country of the materials to be used, and the presence of an adequate water supply. The future of silver reduction in Australia must surely be an interesting one to all chemists and metallurgists; and when the labour question shall have been righteously adjusted between man and man, and the spread of technical education produces the skilled workman, there will be no reason why minerals carrying what are now considered ridiculously small quantities of gold and silver should not be economically worked.

A promising step in the right direction is the idea of producing chlorine on the spot from common salt by means of the current of electricity from an ordinary dynamo. The production of chlorine by electrolysis is already a *fait accompli*, and bids fair to prove successful as a commercial undertaking. A process has been patented by Messrs. Richardson and Holland, and recommends itself on the ground of its portability, the materials requisite for working the same being easily transported over great distances. The principle is based on the fact that common salt is decomposed and resolved into its ions, as we have seen, the chlorine being set free next the anode and sodium at the kathode. The chlorine is collected from the surface, while caustic soda remains in the liquor. The chlorine may, however, be allowed to reunite with the sodium, as hypochlorite, if desired. A drawback to its use at first was the resistance caused by the insertion of porous partitions used to separate the ions. This

* Report, Mines Department for 1890, p. 213. Sydney: Government Printer, 1891.

greatly militated against its commercial application, as did the polarisation caused by the evolution of hydrogen from the decomposition of the water present. To overcome these difficulties, the porous partition of the decomposing tank is reduced in size, and copper oxide is introduced to enable the hydrogen to combine with its oxygen, thus leaving behind metallic copper, which is re-oxidised by heating in a current of air and used over and over again. The process may obviously be used in the manufacture of caustic soda and sodium hypochlorite as well as chlorine, according to requirement.

The economical production of caustic soda would enable other wet processes to be used, such as Ellershausen's wet process for the extraction of the precious metals from zinc ores. These latter give rise to grave difficulties in many parts of New South Wales, notably at the Barrier Ranges; in many cases the zinc is lost to the community for want of a suitable process of extraction. The method I refer to is one which can be economically worked in connection with the caustic soda manufacture. The zinc ore is mixed with 25 per cent. of galena, if it does not already contain that quantity of galena, and after being crushed, is put in a reverberatory furnace and heated to a red heat, when from 35 to 50 per cent. of caustic soda (the crude refuse from the soda works) is added. The whole mass fusing, the galena readily gives up its sulphur to the soda, and metallic lead is produced, which, with the gold and silver, sinks to the bottom, the sulphides of iron, copper, and zinc remaining in the slag. The lead is drawn off and cupelled, and the slag, on exposure to the air, rapidly crumbles to powder owing to the caustic soda present, which is afterwards removed by lixiviation, and can be used over again, while the metallic sulphides can be treated by the usual methods. The ore should previously be concentrated to remove quartz, as the soda would be wasted in forming silicate of soda and not recoverable. The late Mr. Wilkinson, my lamented friend, who drew my attention to this interesting process, held the opinion also that the ores of Broken Hill, Moruya, and Castle-Rag could be successfully treated in this way.

In addition to the many forms of chlorinating processes, there remains for me to mention another, the principle of which is that the sulphur present in many sulphide ores may be subjected to a particular degree of oxidation in a reverberatory furnace, whereby the soluble sulphate of silver is formed ;

this is afterwards separated out by leaching with hot water as already described, the silver being separated as metal, while the copper and iron compounds are left as insoluble oxides. This process, known as Ziervogel's, is particularly well suited to argentiferous pyrites carrying from 10 to 40 ozs. of silver per ton.

Another process of wet extraction has been lately patented by Dr. Storer, of Sydney, and Mr. Marsh, of Broken Hill, which may be briefly described, as follows:—The ore is roasted in a reverberatory furnace along with limestone, the mass lixiviated with water, the zinc precipitated by magnesia as hydrate, which on filtration yields nearly pure zinc oxide.

Closely associated with the different processes I have brought before you, as well as with smelting operations generally, is the nature of the fuel and its suitability for metallurgical work. Mr. J. C. Mingaye, Assayer to the N.S.W. Government, has undertaken a thorough examination of the coals and cokes available in New South Wales, and finds them nearly equal in every respect to those of Europe and America, the exceptions being in the refractory nature of the ash of some specimens,—a defect, however, which is partly compensated for by their greater freedom from the undesirable elements phosphorus and sulphur.

The phenomenon of solution is, therefore, of world-wide interest, as we see its application in our arts, industries, and manufactures, as well as in the every-day acts of our lives. And all these changes, velocities, rotations, vortices, and precessions, even if we do not as yet perceive them, have been going on under our very eyes from the beginning; they are still going on in our laboratories and workshops, as well as in the great arena of nature. The truth is, that things constantly before us become so commonplace as to no longer awaken our interest as they did in the freshness of youth. Who has not observed the mixed feelings of awe and wonder when some friend comes, it may be for the first time in his life, to witness some natural phenomenon in a laboratory? Do we not find that such an one thus coming fresh upon the scene, untrammelled and free from preconceived notions, sets us thinking by some original and unanswerable question? There are not wanting among us some who talk of the narrowing tendency of the pursuit of Chemistry as a discipline of the mind. Such a view is totally at variance with fact and experience, since the great issues dependent upon a knowledge of Chemistry, and the enlarged conception of the

universe gained by its study, places it in the front rank as an instrument of great educational value, and one best fitted to bring forward *(educe)* habits of observation and reflection.

One has but to think of the enthusiasm of a Liebig, a Faraday, and a Hofmann, and of the indomitable truth-seeking spirit which animated them, their sufficient reward being the inward satisfaction of having worked out, at first hand, an imperishable fact direct from Nature. To such as these comes the promise of the poet—

> "Thy mind
> Shall be a mansion for all lovely forms ;
> Thy memory be as a dwelling-place
> For all sweet sounds and harmonies."

Even such a mind as that of M. Renan has expressed the regret that he did not dedicate his life to chemistry instead of Oriental languages. Sir Henry Roscoe recently gave a reminiscence of the talented chemist, Dumas, who, after having declared that he had seen every phase of life—student, teacher, professor, minister, senator—but no work had he been called upon to perform had been so satisfactory, or had been looked back upon with such pleasure, as that of carrying on original work; and, he says, "If I had to live my life over again, I would not relinquish my quiet laboratory pursuits for all the splendour and influence of court favour, or the turmoil and rewards of political life."

The advance of our science may be ascribed, not so much to the rewards offered by wealth, as to the disinterested love of truth on the part of the worker; for what man can pursue the even tenor of his way upon research work with the feverish spirit engendered by some pecuniary prize dangling before his eyes? The advance of Science may, moreover, be attributed to the greater freedom of the person, and to the full freedom of thought that can be focussed at will upon everything relating to objective truth.

It was possible with our forefathers not to enquire, but it is fortunately impossible to stem the tide of free enquiry that, like the ether around us, pervades every thinkable subject. We remember, however, that the lives of our forefathers were overshadowed by the gaunt and chilling arm of Authority, which effectually barred the road to knowledge. *Tempora mutantur;* and with our freedom comes the intellectual growth and the desire to ascertain the truth as it may be revealed to us by the infinitely great and by the infinitesimal molecule. Let us not close our minds to the apprecia-

tion of the mutual relationship existing between the divisions of science known as Chemistry, Physics, and Astronomy; for what we know is as nothing to what we do not know and what still remains to be known. This may be a truism—sometimes it is half doubted. To me it seems like the literal truth, and that if we narrow our views to already half-conquered territory only, we shall be false to the men who won our freedom, and treasonable to the highest claims of Science.

And now, with the end in view, I feel conscious of having only touched the fringe of one phase of the all-absorbing subject of the nature of this beautiful universe; but, so far, you will, I think, agree with me in saying that the study of matter in its manifold aspects is not only worthy of our best energies, but full of promise for the future. The hard mechanical conceptions, accompanied by the dread born of an unreasoning superstition, formerly held regarding Nature, the irreverent and loose talk about "brute matter," and of dead motionless matter, is passing away. The "dead" matter is quickened and is alive with movement. What was once taken for absolute rest and immobility is in a state of high tension and rapid motion, yet always in perfect harmony and in keeping with the orderly progress of the universe. Whether we peer out into the ethereal depth inlaid with suns, or whether we observe a crystal of potassium iodide dissolving in water, we have rolling worlds in the one case and the eddying molecule in the other, the gamut of the Universe being complete, from the protean carbon atom to the remotest so-called fixed star. Must we not, therefore, feel that the contemplation of such perfection of structure and such majesty of motion claims both our admiration and attention, and must lead us to recognise that in all around us we have—

Vox Dei in rebus revelata.

As with Lucretius, the gaze of the philosopher of the day is again centred upon the atom. The question still asked is,—What are the atoms?

Ageless units in the amplitude of space,
Outlasting the ravage and the wreck of Time:
Now in a dewdrop distill'd from a rosebud;
Here in a crystal; there poised in a sphere
Evolving from fire-mist new worlds for the future
To vibrate anew the great clarion of Life.
These—these are the atoms.

Section C.

GEOLOGY AND PALÆONTOLOGY.

Address by the President,

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The subject of Volcanic Action in Eastern Australia and Tasmania, with special relation to sedimentation and slow movements of the earth's crust, has been chosen by the author as the subject of the present Address, partly as a sequel to the Presidential Address delivered by Professor Hutton at the meeting of the Geology Section of the Association at Melbourne in 1890, and partly on account of the great local interest which attaches to the vast development of volcanic rocks in the immediate neighbourhood of Hobart, and over a very large area in the south-eastern and northern portions of Tasmania. The author proposes to review briefly the evidences of volcanic action in past geological time in the portion of Australasia above mentioned; then to adduce some theories which may account for such phenomena, and especially to inquire into their possible relation to sedimentation.

As far as the author is aware, the oldest rocks in Eastern Australia, which have been proved indisputably to be of volcanic origin, are the Snowy River porphyries of Eastern Victoria.

Mr. A. W. Howitt, F.G.S., the Under Secretary for Mines in Victoria, refers this group of volcanic rocks either to the top of the Lower Devonian Series or to the base of the Middle Devonian. The series consists of felstone porphyries, felstone ash, and agglomerates.*

The fragmentary portions vary from a fine microscopic dust up to pieces several feet in diameter. The series is about 20 miles wide, 70 miles in length, and upwards of 2000 feet thick.

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* Victoria: Geology and Physical Geography, by Reginald A. F. Murray Government Printer, Melbourne, 1887.—pp. 48-52.

In the mountain known as the Cobboras, in Eastern Victoria, it attains an elevation of 6000 feet above the level of the sea, sloping down to an altitude of about 1000 feet, where it disappears under the marine Tertiaries near the coast. The series rests uncomformably on Silurian sediments, the latter having a thickness of perhaps 30,000 feet, and is capped in places by limestones of Middle Devonian age.

Mr. Howitt considers that these rocks were erupted from a series of volcanoes on a meridional line of fissure, the Cobboras forming the denuded stump of one of them. The lavas and tuffs of this series are considered to be chiefly subaerial, but partly subaqueous.

Mr. Murray remarks with reference to these volcanoes,* "This volcanic chain probably resembled, on a smaller scale, that now in action in the Andes of South America. Its position is worthy of notice, as it includes portion of the present Cordillera, and extends southward from where the latter now diverges suddenly to the west of Forest Hill directly in the line of prolongation of the general course of the Cordillera through New South Wales from Mount Kosciusko to Forest Hill, and the general bearing of the chain from Forest Hill to the mouth of the Snowy would, if produced, run through Tasmania. Whether the crest of the land surface, which once connected Australia with Tasmania, was on this line or further to the westward is a matter of speculation, but it does not appear unlikely that the igneous belt extended to Tasmania, either as a wholly terrestrial or partially marine chain of volcanoes. If the former, the connection as a land surface was probably severed by denudation early in Middle Devonian times. It would be interesting to ascertain whether, in the older igneous rocks of Tasmania, the same evidences are observable as those which justify the conclusions arrived at by Mr. Howitt as to the origin of the Snowy River belt of porphyries."

By the severance of Tasmania from Australia in the Middle Devonian time, Mr. Murray presumably means the temporary severance, as of course the fauna and flora of Tasmania both indicate that the final severance of Tasmania from Australia did not take place until late Tertiary or possibly even Post-Tertiary times. The suggestion of Mr. Murray's that this chain of Lower Devonian volcanoes may have been continuous into Tasmania is worthy of the consideration of Tasmanian geologists. If Mr. R. M. Johnston's cautiously

* *Loc. cit.*, pp. 76-77.

expressed views as to the age of the diabasic greenstones constituting the tiers of the south-eastern portion of Tasmania are correct, and they really antedate the Permo-Carboniferous Period, it is possible that they may be related either to the Snowy River porphyries, or to the volcanic rocks of Middle or to those in the Upper Devonian series of Victoria. The author, however, for reasons which will be discussed in more detail in his paper on the Permo-Carboniferous Volcanic Rocks of New South Wales, considers that the bulk of the Tiers of Tasmania are probably of newer date than the Permo-Carboniferous period, and newer even than the Mesozoic Coal Measures of New Town, near Hobart, of Jerusalem, Fingal, &c. This volcanic action in the Lower Devonian age was probably prolonged at intervals into that of the Middle Devonian, as interstratified with the Buchan group of Middle Devonian age are felsite breccias and felsite tuffs with a sheet of compact felsite and one of basalt. Mr. Howitt remarks*—"The general conditions indicated are, I think, these :—

"1. A sinking coast-line, with either marine or littoral volcanoes, from which trachytic materials were ejected as fragments, or emitted as flows of lava (felsite breccias, tufas, compact and porphyritic felsites).

"2. Gradual extinction of volcanic activity, as indicated by the finer character of the felsite fragments, their intermixtures with calcareous materials (calcareous felsite-tufas), and their final cessation with succession of purely marine limestones."

In the Upper Devonian series of Eastern Victoria, contemporaneous melaphyres occur interbedded with Upper Devonian rocks, and underlying the Avon River sandstones, which latter are characterised by the presence of *Lepidodendron Australe*. Derived blocks of melaphyre are found in conglomerates underlying the lepidodendron beds.

The melaphyres appear to represent the last products of volcanic action in Victoria during the Palæozoic era.

The following may be taken as a summary of the events which preceded and immediately succeeded the volcanic outbursts in Victoria during the Devonian period :—

Silurian strata were deposited in horizontal layers to a depth of about 30,000 feet. These strata were then plicated

* *Loc. cit.*, p. 55.

and the main axis of the Australian Cordillera determined. Upheaval, therefore, followed after prolonged subsidence.

At the close of the Lower Devonian age a great series of terrestrial volcanoes broke out on a north-and-south line from near the Cobboras southerly towards Tasmania. At the close of the Lower Devonian age the land surface sank, but volcanic activity did not entirely die out until deposition of the Buchan limestones of Middle Devonian age.

A considerable subsidence then took place, accompanied by a complete cessation of volcanic activity.

Finally, before the deposition of the Upper Devonian series the Lower and Middle Devonian rocks were uplifted and folded to such an extent that in some places in Victoria the Middle Devonian rocks are vertical, whereas the overlying Upper Devonian rocks are horizontal and comparatively undisturbed.

The Upper Devonian rocks of the Avon River were next deposited, and contemporaneously with their formation lavas of a basic character were outpoured. These eruptions probably took place on an area of subsidence, though the downward movement must have ceased about the time when the last of these melaphyre sheets was erupted, as freshwater beds containing lepidodendrons conformably overlie the melaphyres.

Very little folding appears to have taken place in the Victorian rocks subsequent to the close of the Middle Devonian period, the Upper Devonian and Carboniferous rocks being only slightly uplifted and compressed.

In New South Wales abundant evidence of contemporaneous volcanic action during the Carboniferous period is afforded by the thick beds of diabasic and felsitic tuffs, together with sheets of felsite and diabasic basalt interstratified with the *Rhacopteris* beds, which form the Upper division of the Carboniferous system in New South Wales, the Lower division being specially characterised by lepidodendrons. The total thickness of the Upper portion of the Carboniferous beds in the Stroud District of New South Wales is at least ten thousand feet, and out of this probably not less than one-third is composed of contemporaneous volcanic rocks, these being the oldest known lavas and tuffs in New South Wales. Little, however, is at present known of the conditions under which these lavas and tuffs were formed, beyond the fact that prior to their eruption a considerable thickness of marine carboniferous sediments were deposited, and that the scene

of the eruptions was contiguous to the coast line of that period.

In Queensland, in the Bowen River Coal-field extensive eruptions of a diabasic character took place some time probably about the close of the Carboniferous period or at the commencement of the Permo-Carboniferous period. These lavas, termed "bedded porphyrites" by Mr. R. L. Jack, F.G.S., Government Geologist of Queensland, immediately underlie the lowest members of the Marine Permo-Carboniferous group, being capped by a formation which can be directly correlated with the Lower Marine series of New South Wales. Lithologically these porphyrites closely resemble the Permo-Carboniferous lavas of New South Wales, though they must be geologically older. The occurrence of carbonate of copper in the steam-holes of the porphyrite, and the presence of metallic copper in the lavas of Permo-Carboniferous age at Kiama, and at the Canobolas, near Orange, in New South Wales, is somewhat remarkable, though perhaps merely an accidental point of resemblance, and not necessarily implying that these lavas were erupted synchronously with the porphyrites.

Although now far inland, the Bowen River porphyrites, if lavas, must have been erupted from volcanoes fringing a shore-line, and their eruption was followed by a considerable subsidence, during which the Upper Marine series and overlying Coal Measures of Permo-Carboniferous age were formed, the aggregate thickness of which Mr. Jack estimates at about 2800 feet.

In New South Wales during the Permo-Carboniferous period volcanic energy manifested itself on a grand scale in those areas which were contiguous to the margin of the Permo-Carboniferous ocean, and which also bordered on areas where heavy sedimentation was in progress. In the neighbourhood of Raymond Terrace, near Maitland, marine Permo-Carboniferous sediments, having a thickness of at least 2000 feet, were deposited in a great basin forming an arm of the sea, which perhaps completely severed the New England table-land from the Alpine plateau in the southern portion of New South Wales. While, however, the central portions of this basin where the sedimentation was most heavy were undergoing subsidence, the north-eastern shore-line of this Permo-Carboniferous sea was probably either stationary or rising. Contemporaneously with the formation of the Greta Coal Measures in the Raymond Terrace District,

a chain of volcanoes appears to have commenced to form on a north-west and south-east line, following approximately the trend of the coast of that period

An interesting section lately exposed at the Seven Miles, near Raymond Terrace, shows that these eruptions commenced just prior to the commencement of the formation of the Greta Coal Measures. Showers of volcanic dust, which accumulated in places to a depth of over one hundred feet, fell on the surface of the low-lying land or swamp-flats where the coal was commencing to accumulate. Hence, in this district portion of the Greta seams were actually formed on a bed of volcanic tuff. This seam at the Seven Mile has thin layers of volcanic tuff interstratified with it, and is capped by a thickness of about 300 feet of strata composed partly of tuffs and partly of a mixture of subaqueous tuffs and clay-shale very carbonaceous in places.

Thick sheets of lava, which may provisionally be termed a diabasic dolerite, then covered these tuff-beds, there being at least two distinct lava flows separated from one another by tuff-beds, and by thin layers of coal much intermixed with tuffaceous material. The whole of this volcanic series, including the tuffs, has a thickness of from 1000 to 2000 feet.

One of the points of eruption of these volcanic rocks was probably the hill called Paddy's Sugar-loaf, between Raymond Terrace and Stroud.

In the Illawarra Coal-field volcanic energy developed itself a little later than at Raymond Terrace, and, in this case, the horizon of the volcanic rocks lies over 2000 feet above the Greta Coal Measures, at the top of the Permo-Carboniferous Upper Marine series, and at the base of the Permo-Carboniferous Bulli Coal Measures.

The contemporaneity of these lavas and tuffs with the Permo-Carboniferous system was first pointed out by the late Government Geologist of New South Wales, Mr. C. S. Wilkinson.

This volcanic series is from 1000 feet to 1400 feet thick, and is built up of at least three sheets of lava and one thick bed of coarse red tuff. The eruptions commenced with andesitic dolerites, and concluded with olivine basalts. The former contain metallic copper in small quantities in minute shrinkage cracks throughout their mass. The volcano which poured out those lavas and tuffs near Kiama was probably in its first stages submarine, and made its appearance in the shallow Permo-Carboniferous ocean within about thirty miles

of the shore-line to the south-west, the latter being composed of highly folded and foliated Silurian rocks.

This volcano appears to have been formed at the time of the cessation of the prolonged subsidence of the floor of the Permo-Carboniferous ocean between Ulladulla and Raymond Terrace, the subsidence being due to this part of the earth's crust being loaded with over 2000 feet of Lower Marine and 5000 feet of Upper Marine sediment.

The older lavas of the Canobolas, near Orange, may also have been erupted about this date. Near Rylstone, and in the Murrurundi District, in New South Wales, there is abundant evidence of volcanic action being continued into the age of the Middle, and, perhaps, even into that of the Upper Permo-Carboniferous Coal Measures, the volcanoes in each case being situated in close proximity to the shore-lines of the Permo-Carboniferous ocean.

At the close of the Permo-Carboniferous period an additional 3000 feet of sediment had been added in some localities to the 7000 feet of Permo-Carboniferous rocks already deposited, and in the succeeding basement beds of the Hawkesbury series there is evidence of a return of volcanic activity on a small scale, in the shape of contemporaneous tuffs, which occur on various horizons in the Hawkesbury Series up to a level of about 2000 feet above the top of the Permo-Carboniferous Coal Measures.

With the deposition of the Hawkesbury sandstone and of the Wianamatta shales the exceptionally heavy sedimentation of the Permo-Carboniferous period and of the Lower Mesozoic rocks was brought to a close; and there is no evidence of a return of volcanic activity to New South Wales, or, at all events, to the eastern portion of it, until Tertiary time, unless, perhaps, the small sheets of leucite basalt at Byrock and El Capitan may be referred to some time about the close of the Mesozoic era. It is a remarkable fact that there are no sediments of any thickness in that portion of New South Wales which intervenes between the Cordillera and the ocean older than early Mesozoic, and during the long period of time which intervened between the formation of the last of the Hawkesbury rocks and the commencement of the Tertiary era the eastern portion of New South Wales was not again visited by volcanic outbursts.

In the Lower Mesozoic rocks of Queensland of Triassic or Lower Jurassic age, Mr. Jack describes the occurrence

of tuffaceous sandstones, as, for instance, in the Ipswich Coal Measures, and Mr. A. W. Howitt records a similar occurrence in homotaxial rocks in Victoria. These statements argue that there must have been a certain amount of contemporaneous volcanic activity in Australia in early Mesozoic time. Lava sheets, however, belonging to this period seem to be wanting, as far as the author is aware.

In Tasmania, however, perhaps in Mesozoic time, a little later than that during which the Hawkesbury series of Sydney and the Ipswich Coal Measures of Queensland were formed, volcanic energy developed itself on a grand scale, and has left lasting monuments of its powerful work in the shape of the Tiers which form such an important physical and geological feature in the south-eastern and northern portions of Tasmania.

The age of these diabasic greenstones is, at present, by no means settled. The author is inclined to think, for reasons which will be given in a subsequent paper, that the greater part of them are later than the Mesozoic coal-fields of Jerusalem, Seymour, &c., and than the coal-field of New Town, near Hobart. If this view as to the age of the Tiers is correct, their eruption may have been directly due to the prolonged and heavy sedimentation which produced the Permo-Carboniferons marine sediments of the estuary of the Derwent, &c. The thickness of the latter must amount to several thousand feet. It may be argued that such a vast amount of time has elapsed between the deposition of the uppermost of the marine sediments of the Permo-Carboniferous and the formation of the New Town Coal Measures that it is extravagant to assume that any volcanic action developed subsequent to the formation of the latter is attributable to heavy sedimentation in Permo-Carboniferous time; but the author has the authority of Mr. R. M. Johnston for saying that there is a conformable upward passage from the top of the Permo-Carboniferous Marine Beds into the New Town Coal Measures, and the flora of the latter is certainly characterised by a commingling of Australian Lower Mesozoic plants with those of Upper Palæozoic affinities, though, on the whole, the facies of the flora is decidedly Mesozoic.

The suggestion, therefore, may not be unreasonable, that the extrusion of the basic rocks composing the Tiers may have been due to heavy sedimentation.

With the exception of some comparatively insignificant

tuffaceous beds in the Desert Sandstone of Queensland, which is considered to be of Upper Cretaceous age, there is no evidence, as far as the author is aware, of contemporaneous volcanic action in Australia in Mesozoic rocks of Jurassic or of Cretaceous age.

During these long periods of time the western portions of New South Wales and Queensland were slowly subsiding under the waters of the Cretaceous ocean, which may have extended from the Gulf of Carpentaria on the north southwards at least as far as Nevertire, in New South Wales.

In some parts of Queensland the subsidence may have been as much as 3000 feet, and in New South Wales upwards of 1000 feet. At the close of the Mesozoic era subsidence ceased, and a re-elevation of the Western Districts commenced.

In Tertiary time there was a great renewal of volcanic activity in Queensland, New South Wales, and Victoria.

In New South Wales eruptions commenced in Eocene times. In the tin-bearing districts of New England, as at Tingha and Vegetable Creek, a number of small volcanoes broke out on north-west and south-east lines, and built up composite cones of lava and tuff to a height of from 100 to about 500 feet, and remains of the Eocene flora of that epoch became buried under the contemporaneous volcanic rocks. While eruptions were taking place in New South Wales during early Tertiary time, on a rising land surface, Victoria was undergoing subsidence, the land being depressed during the Oligocene or Miocene periods 700 feet below its present level.

In Victoria a few thin volcanic rocks are interstratified with the Miocene sedimentary beds, but as far as at present known there are no equivalents of the Eocene volcanic rocks of New South Wales developed in Victoria. The greatest volcanic activity, however, in the latter country took place during the close of the Miocene period.

No well-marked points of eruption, however, of these lavas, which are basalts, and termed "Older Volcanic" by the Victorian geologists, have yet been discovered. This absence of relics of the Miocene volcanoes of Victoria is probably due to the great amount of denudation to which the Miocene basalts were subjected, as in the Victorian basalt flows, termed "Newer Volcanic," which commenced in the Pliocene and extended down to probably recent geological time, there are numerous and well preserved volcanic cones and craters.

After the outpouring of the older volcanic rocks in Victoria a subsidence took place over a wide area occupied by the older basalts to the extent probably of at least 300 feet.

Mr. Murray remarks that "this would appear to be the last important downward movement of the Victorian land, which seems to have subsequently risen gradually, with a few minor oscillations, to its present status." During the gradual rising of the land surface volcanic eruptions took place at the close of the Lower Pliocene period and during the Upper Pliocene.

While this elevation of the Victorian land was in progress the zone of volcanic activity in that country appears to have followed the southern shore-line, which was constantly retreating southwards. One of the most recent of the Victorian, and probably of Australian volcanoes, is that of Tower Hill, near Warrnambool. Its comparatively recent age was proved by the discovery of the complete skeleton of a dingo under 63 feet of volcanic tuff of a basic character. This skeleton was found reposing on the scorched grass of an old land surface of Post-Tertiary age, as described by Professor Selwyn. The tuffs and small basalt lava streams of Mount Gambier, in South Australia, perhaps are of almost as recent age as those of Tower Hill. The author has the authority of Professor Tate, of Adelaide University, for saying that the volcanic rocks of Mount Gambier overlie mammaliferous drifts containing remains of *Diprotodon*; and the Rev. J. E. Tenison-Woods, F.G.S., had previously shown that this volcano or group of volcanic vents must obviously have been of later date than the Mount Gambier limestone, the latter being of late Tertiary age, as large fragments of this rock occur interbedded in the volcanic tuffs of the same locality.

A summary of the conditions which obtained in New South Wales and Victoria during Tertiary time favours the supposition that in the Eocene period the western portion of New South Wales was rising, thereby driving back the waters of the Cretaceous ocean towards the Gulf of Carpentaria. Near this rising coast-line there sprung up a chain of volcanoes, from which were erupted the oldest basalt lavas and tuffs of New England. While this elevation of the land was in progress in New South Wales, Victoria was undergoing depression, and the Oligocene and portion of the Miocene marine beds were laid down. Before the subsidence had completely ceased, but chiefly after its cessation, and

while elevation was in progress, extensive outbursts occurred of basaltic lavas and tuffs. A slight subsidence followed, succeeded by re-elevation, and then on the slowly rising coastal areas eruptions took place of the newer basalts, the volcanic centres progressively shifting their position southwards as the shore-line, owing to the elevation of the land, gradually receded in the same direction.

In Tasmania, during the Tertiary era eruptions of basalt and basalt tuffs occurred on a large scale, as described by Mr. R. M. Johnston, F.L.S.* At Breadalbane forests of conifers and angiosperms are stated to have been overwhelmned by the lava.

In the neighbourhood of Launceston the felspathic basalts are considered by Mr. Johnston to belong to the Older Tertiary period.

At One-Tree Point, near Hobart, traces have been discovered of a bone breccia imbedded in the cooling joints of a partly denuded surface of an older flow of basalt, and capped by a solid sheet of newer basalt. The breccia is stated to contain bones and teeth belonging to marsupials of the following genera :—*Hypsiprymnus*, *Phalangista*, and *Phascolomys*.

The occurrence of nepheline in the Tertiary basalts of Tasmania, as described by Mr. Johnston, is not yet certainly established, as the author was informed by Mr. Johnston and Professor G. H. F. Ulrich, of Dunedin University.

At present the information available is insufficient to justify any conclusion as to whether the volcanic outbursts in Tasmania in Tertiary time were subsequent to heavy sedimentation, or whether they took place during an elevation or during a depression of the land. In the case, however, of the Tertiary lacustrine beds in the neighbourhood of Launceston, which are capped by basalts over considerable areas, there is evidence of subsidence having taken place previous to the eruption of the basalt, to the extent of, perhaps, several hundred feet. At the bore for coal at Belmont, near Longford, in the centre of this basin, the Tertiary beds were proved to have a thickness of at least 894 feet,† Tertiary fossil-wood being found down to that depth. The whole of this thickness of sediment accumulated before the eruption of the basalt, and, as the surface-level at the Belmont bore is probably not more than 700 feet above

* Geology of Tasmania: R. M. Johnston, F.L.S., p. 273.
† *Loc. cit.*, pp. 275-276.

sea-level, it is evident that a subsidence of about 200 feet would be necessary in order to bring the beds containing the Tertiary fossil-wood down to their present level, on the assumption that they were originally laid down at or above sea-level.

Whether or not the subsidence which took place during the accumulation of the Tertiary beds of the Launceston basin had any relation to the formation of Bass Straits is not at present known.

Mr. Johnston is of opinion that the depression which contributed to form Bass Straits occurred during the later Tertiary and earlier Post-Tertiary periods, in which case Bass Straits were probably formed at a later date than that of the eruption of the basalts of the Launceston basin.

Before proceeding to summarise the evidence so far adduced as to the possible relation of volcanic action in Eastern Australia and Tasmania to heavy sedimentation and oscillations of the earth's crust, it may be well for the author to review briefly some theories which seem to offer a reasonable explanation of this probable relationship.

Assuming that the earth was originally formed from the condensation of a nebula, Messrs. Nasmyth and Carpenter have shown how a globe of molten matter like the earth or the moon cooling in concentric shells from its surface inwards would be subject to superficial outbursts of volcanic activity. As the first crust (*a*) underwent solidification it would undergo expansion, but, as there would be nothing above it but the atmosphere to resist this expansion, no considerable disturbance of the earth's crust would ensue. In the second stage of cooling, owing to further loss of heat, the first-formed crust would contract, and this contraction would be resisted by the expansion which would simultaneously be set up in the zone (*b*) undergoing solidification, and therefore expansion immediately under the first cooled crust (*a*). The result of the opposing action of these two zones would be to exert immense bursting force upon the outer zone (*a*). The action of the expanding zone (*b*) at this stage might be compared to that of water bursting iron pipes consequent on its expansion when approaching the freezing point, or to that of molten bismuth when at the point of solidifying, it being a well known fact that that metal undergoes expansion when solidifying to such an extent that if, when molten, it be poured into an iron bottle so that the latter is completely filled, and the stopper be screwed down to prevent its escape, the bottle will

be burst by the bismuth as the latter passes into the solid state.

Cracks therefore may be produced in the crust (*a*) into which molten material may be squeezed, derived either from the re-fusion, consequent on the relief of pressure, of portion of the already solidified zone (*b*), or from the liquid or potentially liquid nucleus of the earth below the latter zone.

It may be objected at this point that the opposing forces of the expanding zone (*b*) and the contracting zone (*a*) may so exactly balance one another that no squeeze will be exerted on the nucleus, and there will therefore be a zone of no strain between the exterior of the nucleus and the lower limit of zone (*b*). This might conceivably be the case if the radial and circumferential expansion of zone (*b*) proceeded at an equal rate, so that the surface of zone (*b*) would not undergo any appreciable deformation, and provided zone (*b*) possessed the necessary rigidity to not only sustain its own weight without support from the underlying nucleus, but also to bear the weight and contractile force of zone (*a*),—an exceedingly improbable hypothesis, which might be illustrated by the following example, which ought to be specially familiar to Australians. If the axle of a vehicle becomes jammed in the axle-box owing to the axle becoming overheated, the axle-box can be loosened either by chilling the axle or heating the axle-box. If the latter course be adopted, the axle-box, undergoing equal radial and circumferential expansion consequent on being heated, gradually lifts itself away radially from the axle, and so loosens its hold and ceases to compress the axle; and this expansion of the axle-box by heat will ensue in spite of the slight compressory force which may be exerted on its exterior by the wooden naves of the wheel. In this example the wooden nave would represent zone (*a*) the axle-box zone (*b*), and the axle the nucleus of the earth.

It is, however, improbable that the solidifying zone would possess such an enormous strength and rigidity as this hypothesis would demand, and consequently a squeezing force would be exerted on the nucleus, which would tend to force up its material into any cracks formed in zone (*a*) or zone (*b*), and so produce volcanic outbursts.

In the third stage of cooling it may be assumed that a third zone (*c*) undergoes solidification, while (*b*) passes into the contractile position. Zone (*a*), however, having lost nearly all its heat capable of rapid radiation, radiates heat so slowly that its contraction practically ceases. As, however,

contraction is still progressing rapidly in zone (*b*), the latter tends to shrink away from zone (*a*) so as to leave it unsupported. Zone (*a*) consequently is thrown into wrinkles to accommodate itself to the surface of the zone of maximum contraction (*b*), the line of junction between (*a*) and (*b*) being termed the zone of no strain.

Volcanic outbursts may take place in this third stage from the same causes as in the second stage, the chief difference being that the material from the nucleus has now to pass through three zones instead of the two before it reaches the earth's surface.

If this theory be applicable to the original crust of the earth it should apply equally to explain the causes of volcanic action in the present crust, the chief alteration in the conditions being that the zone (*a*) of minimum radiation and maximum is now largely composed of sedimentary rocks, instead of being wholly volcanic, as they probably were when the original crust was formed.

The theory above quoted is only one of many which may be only partially true. It serves, however, to show that secular contraction of the zone (*b*), and perhaps expansion of the solidifying zone (*c*), are probably the primary causes of volcanic action.

Before explaining how heavy sedimentation may assist secular contraction in producing volcanic eruptions, reference must be made to the probable physical condition and chemical composition of the rocks composing these zones. If the assumption be correct that the rate of increase in temperature downwards in the earth's crust after the line of mean surface temperature is passed is about 1° Fahr. for every 63 feet of descent, it follows that at a depth of about six or seven miles a temperature of about 700° Fahr. might be reached, which is probably, for many well known reasons, the lowest temperature at which granite is likely to form, so that this depth of seven miles may mark the extreme upward limit of the granites, which, for convenience of reference, may be termed the isogeotherm of 700° Fahr. This depth, therefore, should theoretically lie below the zone (*a*) of maximum compression ; and earthquake observations are somewhat in harmony with this theory, as, except in the neighbourhood of volcanoes, it is unusual for the point of origin of an earthquake to lie at a less depth than from five to six miles, and earthquake shocks are more liable to originate in the zone (*b*) of maximum contraction than in the zone (*a*) of maximum

compression. Below the lighter granitic magma should lie—first, rocks of chemical composition and specific gravity intermediate between those of the granites and basalts, then the basalts, and, lastly, the ultrabasic rocks.

The depth at which the basalts might first be reached below the earth's surface might exceed twenty miles if the observed temperature, 2200° Fahr., at which they issue from volcanoes can be taken as a test, and the rate of increase above quoted be applicable as a constant to such a depth.

For convenience, the possible upward limit of the basalts may be termed the isogeotherm of 2200° Fahr. When heavy sedimentation takes place over any portion of the earth's crust, that portion of the crust usually subsides under the load. As it sinks the isogeotherms sink with it, though at a less rapid rate, and so this part of the earth's crust becomes temporarily extra through having its thickness increased proportionately to the increase in thickness of the sediments. This probably is the reason, as shown by Professor Prestwich, Professor Hutton, Mr. Mellard Reade, &c. why volcanic action seldom occurs in areas of subsidence. Sedimentation, however, at once introduces a local element of weakness by bending the earth's crust out of its normal curve, and volcanic action may occur even while subsidence is still in progress along such lines of sharp fold. More often the greatly increased thickness of the cold portion of the earth's crust owing to the temporary depression of the isogeotherms more than compensate for the weakness in the crust caused by downward bulging, and the result is a temporary checking of volcanic activity.

In time, however, if the sediment be assumed to have attained a thickness of about 30,000 feet, it may reach a level below the earth's surface at which the temperature and pressure under normal conditions may be sufficiently high to cause the actual fusion of the rock, and its fusion would be much accelerated by the large amount of quarry water contained interstitially in the sediments. Previous to the fusion of the overlying sediments the original crust, formerly hard, upon which they were deposited, may be rendered plastic by the rise of the isogeotherms, and then this region of sedimentation at once becomes an area of weakness in the earth's crust, and a fit spot upon which the contracting zone of the earth's crust may expend its force. This contraction will exercise a squeezing action on the liquid or potentially liquid portions of the earth's nucleus

which underlaid the original crust, with the result that some magma will be forced up, and a volcanic eruption will be produced.

If, however, the eruption be situated within the area of heavy sedimentation the resulting lavas will usually be, not the light acidic obsidians or rhyolites, but the heavy basalts, owing to the displacement of the acid granitic magma from under the area of sedimentation, owing to the downward bulging of this loaded portion of the crust.

For the same reason submarine eruptions usually produce basalts owing to the great depression which the crust has undergone under oceanic basins having led to the light granite magma having worked its way from under them towards continental areas where it is capable of rising under the crust to a higher altitude than it can in submarine areas. Thus the tendency probably is for granitic magma to leave areas of subsidence or any low-lying portions of the earth's crust and concentrate itself under the higher portions of continents in a manner analogous to the rock oil of the United States, which, owing to its being of less density than water when imprisoned in undulating water-bearing strata, withdraws itself from the synclinal troughs and concentrates itself along the arches of anticlines. This slow migration of the granitic magma may be assisted, as pointed out by Mr. Mellard Reade and Professor Hutton, by internal earth tides, if such exist.

In order that basic eruptions may be produced as a result of sedimentation, it is not necessary to assume that the sediments must attain a thickness of about twenty miles in order to bring them down to the normal level of the isogeotherm of the basalts. Volcanic eruptions, even when of a general basic character, usually produce lavas of an intermediate composition at their commencement, and afterwards basalts.

This sequence of volcanic rocks, which has frequently been observed in other portions of the world, is confirmed by the evidence at present attainable in Australia.

If these theories be now applied to afford a possible explanation of the volcanic phenomena of Eastern Australia and Tasmania discussed in this paper, it appears to the author that the following conclusions may be tentatively suggested. During the deposition of the 30,000 feet of Upper and Lower Silurian sediment there is no evidence of contemporaneous volcanic action. The Silurian rocks were then plicated, uplifted, and partly denuded to form the lower

beds of the Lower Devonian series. Towards the later part of the Lower Devonian, when the portion of the earth's crust in Eastern Victoria was probably stationary, great eruptions took place, forming lofty subaerial volcanic cones. With the subsidence, which succeeded in early Middle Devonian time, volcanic activity became locally extinct. The Middle Devonian beds were then folded, and the Upper Devonian were deposited unconformably upon them. Probably before the subsidence, which took place in Upper Devonian time, was completed, basaltic eruptions supervened. The volcanic evidences in the Devonian beds of Victoria therefore favour the inference that volcanic action ceased locally in those areas of the earth's crust which were subsiding, but returned as soon as they became nearly stationary or commenced to be re-elevated.

The evidence in Victoria is probably as yet insufficient to justify the conclusion that there was a direct relation in Devonian time between volcanic activity and sedimentation in that country.

In the case, however, of the Permo-Carboniferous volcanic rocks of New South Wales, there is, in the author's opinion, a distinct relation between sedimentation and the volcanic outbursts of that period, as it is chiefly in those areas where the Permo-Carboniferous sediments acquired a thickness of several thousand feet that volcanic energy manifested itself. These eruptions were all situated at no great distance from the shore-line of the Permo-Carboniferous ocean.

The eruptions of basalt in the Tertiary and Post-Tertiary eras in Victoria, and in the Tertiary era in New South Wales, appear to have taken place chiefly in those areas where the earth's crust was stationary or undergoing elevation, but to have ceased during subsidence.

The comparative thinness, however, of the Tertiary sediments in Victoria and New South Wales does not warrant the opinion that the volcanic action during the Eocene, Miocene, Pliocene, or Pleistocene ages in either of those countries was directly due to or assisted by sedimentation.

There appears to have been a tendency on the part of the Victorian volcanoes to migrate southwards, as the coast-line receded in the same direction.

As regards the highly interesting series of volcanic rocks in Tasmania we as yet know very little. What we do know is due to the labours of Count Strzelecki, Chas. Gould, Rev. J. E. Tenison-Woods, F.G.S., R. M. Johnston, T. Stephens,

M.A., Morton Allport, T. Hainsworth, and many other enthusiastic workers in Tasmanian Geology.

The Government of Tasmania have acted wisely, in the author's opinion, in appointing a Government Geologist in the person of Mr. A. Montgomery, M.A., for it is only by systematic geological survey work, carried out under the supervision of a competent officer, that such problems as those of the relations of the diabasic greenstones of the Tiers to the Coal Measures of Tasmania can be determined,—a question of vast commercial as well as scientific interest. It is to be hoped that during the visit of the Geological Section of the Association to Tasmania something may be done by the combined efforts of Tasmanian, New Zealand, and Australian geologists towards elucidating this great problem, at all events in the neighbourhood of Hobart. The author ventures to think that he is expressing the views of the geological visitors to this meeting of the Association in saying that many of them, at any rate, have come to Hobart in the hope of learning something new from Tasmanian geologists about the geology of their own country; and in return for the information which the latter have already so kindly volunteered to give, the visitors are ready to place at their disposal the best of their knowledge, which, in whatsoever portion of Australasia it may have been gained, has been gained in some part of what was once in past geological time one and the same great Australasian Continent, and it would consequently be impossible for geologists to thoroughly understand its past faunas, floras, and physical geography if they studied them only within the artificial or natural barriers which now separate the Australasian Colonies. Geologists perhaps more than any other scientific men in Australasia need federation, and they have to thank the promoters and supporters of the Australasian Association for the Advancement of Science that that federation is now an accomplished fact.

Section D.

BIOLOGY.—THE FAUNA AND ZOOLOGICAL RELATIONSHIPS OF TASMANIA.

ADDRESS BY THE PRESIDENT,

W. BALDWIN SPENCER, M.A.,

Professor of Biology in the University of Melbourne.

I AM venturing to submit to you to-day, at this the first meeting of our Section in Tasmania, an Address which consists mainly of a summary of the work of others and is an attempt to indicate the present extent of our knowledge with regard to the Fauna and Zoological relationships of Tasmania.

Prominent amongst those who have investigated the Fauna of the Island we may mention the names of Professor Tate, Rev. J. Tenison-Woods, Dr. Ramsay, Colonel Legge, and Messrs. Morton Allport, Legrand, Cox, Brazier, Masters, Johnston, and Petterd. To these we must add that of Sir William Macleay, whose recent death has left so great a blank amongst the biologists of Australasia and whose work and generous encouragement of biological studies will long be gratefully remembered. To his efforts is due the existence of what is undoubtedly the foremost scientific society of Australasia—the Linnean Society of New South Wales—in the journal of which have appeared so great a number of valuable memoirs dealing especially with the Zoology and Botany of Australasia.

Whilst much has been done towards elucidating the natural history of the various colonies much yet remains to be accomplished, especially in regard to the lower groups of animals. In this paper I shall deal simply with the terrestrial and freshwater forms and attempt, so far as I am able, to bring together and summarise the results of different workers in the various groups.

Of the Protozoa and Coelenterata we have no knowledge whatever and of the Vermes but little.

Vermes.

Members of three groups of the latter have been described, viz., Turbellaria, Nemertea, and Oligochæta.

The Turbellaria are well represented in Victoria and New South Wales. The only published account of a Tasmanian form is that of *Geoplana tasmaniana* which was noted by Darwin and is the earliest described land planarian of the Australasian region. In the latter three genera are now known, viz., *Geoplana*, *Rhynchodemus* and *Cotyloplana*, of which the latter is confined to Lord Howe Island.

Moseley, Fletcher, Hamilton, and Dendy have principally described the hitherto obtained Australian forms. In New South Wales eleven species of *Geoplana* are described, and in Victoria 26. Of these four species only are common to the two colonies. Of *Rhynchodemus* New South Wales has six species, Victoria two and Tasmania none. Dr. Dendy has been kind enough to inform me that he has in his collection four as yet unrecorded forms of *Geoplana* from Tasmania. Three of these are merely varieties of Victorian forms; one is identical with a Victorian species and on King Island I collected two more species identical with Victorian ones. That is, of seven species six may be regarded as common to the two. Whilst our knowledge is thus as yet small we have a clear indication of a close alliance between Victoria and Tasmania. The distinction between Victoria and New South Wales, on the other hand, is very clearly marked, though *a priori*, owing to land connection, we might have expected to have found a close alliance existing between the two former rather than between Victoria and Tasmania. There is little doubt but that Queensland forms are related to those of New South Wales and thus in the land planarians, as we shall find to be the case in other groups, the dividing range which runs from east to west across Victoria separates a group of northern from a group of southern forms.

In the Nemertea land forms are of rare occurrence. Those yet known are placed in the genus *Geonemertes*, which has one species commonly found in Victoria (*G. australiensis.*) From Tasmania and New South Wales Fletcher has described single specimens which are at most, if not identical with, merely varietal forms of the Victorian species.*

* Since writing the above I have found four more specimens in Tasmania which are undoubtedly identical with the Victorian species.

In the OLIGOCHÆTA we know, as yet, of only three species of Tasmanian earthworms—one from near Hobart and two from King Island. Though there are eleven genera represented in Australia, three in point of numbers may be regarded as dominant, viz., *Cryptodrilus*, *Megascolides*, and *Perichæta*. Thanks to Fletcher the New South Wales earthworm fauna is fairly well known whilst that of Victoria is only now being worked out and that of Tasmania, South Australia and Queensland is scarcely touched. Still our present knowledge seems to indicate the same general result as obtains in the case of the land planarians. At the present time we know of nine genera in New South Wales with fifty-five species of which twenty-one belong to *Cryptodrilus*, twenty to *Perichæta*, and four to *Megascolides*. Now, in Victoria thirty species have so far been described of which nine belong to *Cryptodrilus*, twelve to *Megascolides*, nine to *Perichæta*. In Tasmania, of the three described species two belong to *Megascolides* and one to *Cryptodrilus* whilst an undescribed form of *Perichæta* has been collected. Whilst the three genera are common to New South Wales, Victoria and Tasmania, the species with few exceptions are very restricted in their distribution and there is only one yet known common to New South Wales and Victoria (*P. fastigatus.*) It is worthy of note that, so far as we know it yet, the earthworm fauna north of the Victorian Dividing Range is marked by the preponderance of the genus *Cryptodrilus* whilst to the south its place is taken by the genus *Megascolides* and we have further an indication that in this important respect Tasmania will probably be found to resemble Victoria. At any rate representatives of the three genera most widely distributed in Victoria have been found in Tasmania whilst south of the Dividing Ranges no specimens of the genera *Digaster*, *Perissogaster*, or *Didymogaster* have been recorded. The oligochætous fauna of New Zealand has been worked out by Beddard and it is of importance to notice that the prevailing genus there is *Acanthodrilus*.

Now on the Australian Continent two species only of this genus have been described, one from Cape York and the other from King's Sound in the N.W. None are known from New South Wales, Victoria, or, as yet, Tasmania. On the other hand the genus occurs in New Caledonia, Patagonia, Falkland Islands, S. Georgia, Kerguelen and Marion Islands and in S. Africa, a distribution

which seems to indicate a curious relationship between these southerly-lying lands and to, at first sight, lend colour to the view held by Beddard that there must have been a northerly movement of the genus from its original home in an Antarctic continent. It will be of interest to determine whether or not this form occurs in Tasmania and if, as seems most probable, it does not, then it will be somewhat curious, supposing this northward migration has taken place, that the form has not reached Tasmania, seeing that it has reached the three other southern land projections. At present its absence from the south and east of Australia and presence in the north and also in New Caledonia would seem to indicate that a southern rather than a northern migration has taken place along the ancient land connection between New Zealand and Northern Australia, some barrier having interposed to prevent its passing down the eastern side of the continent. The present distribution of this, as of other genera, is probably to be best explained by regarding it as the remnant of a once more universal one and there is probably no need to call in the aid of a hypothetical Antarctic continent and a direct land connection between New Zealand, S. America and S. Africa.

Arthropoda.

In the Arthropoda but few groups have been worked out in sufficient detail to enable us to compare the fauna of Tasmania with that of the mainland. Most attention has naturally been paid to the Insecta, whilst the Arachnida and Myriapoda stand much in need of careful investigation. In the latter group it may be noted that one genus *(Henicops)* is common to Tasmania, New Zealand and Chili.

In the Prototracheata Fletcher has described the occurrence of *Peripatus leuckartii*, which is at present regarded as identical with the form found in Victoria, New South Wales and Queensland. In Victoria a second species is found *(P. insignis)*, whilst New Zealand has a species *(P. novæ-zelandiæ)* peculiar to itself. There is some slight difference, however, between the Victorian and New South Wales forms with regard to colour-markings and a more important difference appears to exist in their manner of reproduction. The New South Wales form is undoubtedly viviparous, whilst there is good reason to think that the Victorian form is oviparous. Dendy found that a Victorian

Peripatus kept for some time in captivity had laid eggs. These eggs had shells covered with a definite sculptured pattern, and, since oviposition, the embryos within them have gone on developing, until at the present time Dr. Dendy informs me that the limbs are formed, and the embryos will apparently soon be hatched out. In all probability the Tasmanian will resemble in this respect the Victorian form.

Amongst the INSECTA we are at present obliged to confine ourselves for purposes of comparison to two groups, as lists of forms comprised in the others are, as yet, too incomplete to be useful for this purpose.

(1.) *Lepidoptera.*—In connection with this group important work has been done by Messrs. Walker, Meyrick, and Lucas, whilst a most valuable catalogue has been recently published by Mr. W. H. Miskin dealing with the *Lepidoptera rhopalocera* of Australia. According to the classification adopted by Mr. Miskin there are five families represented in Australia, viz., Papilionidæ, Nymphalidæ, Erycinidæ, Lycænidæ and Hesperidæ. Four of these are represented in Tasmania, the remaining one, the Erycinidæ, having one species only *(Libythæa myrrha)* in Australia, and that confined to Cape York, from which its area of distribution extends over Burmah and India and Ceylon. Altogether Australia and Tasmania have 70 genera of which 24 do not extend south of Queensland, so that, save in the northern and more tropical parts, the region may be regarded as poor in butterflies.

Passing southwards to Tasmania and westwards from Victoria the number in each case undergoes diminution. Thus, whilst Queensland has 62 genera and 257 species, New South Wales has 38 genera and 75 species, Victoria has 23 genera and 54 species and Tasmania 10 genera and 18 species. Passing west from Victoria again, South Australia has 19 genera and 38 species and West Australia 11 genera and 17 species. In the number of genera it will thus be seen that Tasmania stands at the bottom of the list having only one-tenth of the total number whilst in species it has 19 or only one more than W. Australia and only one-eighteenth of the total number of Australian forms. Comparing it with Victoria, we find that all the genera are represented in the latter but 12 Victorian genera are not found in Tasmania. Of the 18 species, 6 are peculiar to the Island, 2 are common to Victoria only, and the rest are widely distributed on the mainland, two forms *(Pyrameis itea* and *P. kershawi)*

passing over to New Zealand, whilst one (*Danais erippus*) is of world-wide distribution. *Xenica*, which is an Australian genus with 9 species most largely found in the S.E. part of the continent, is well represented by 4 species, of which one is peculiar to the island which has also 3 peculiar species of *Lycæna*, a genus including the forms commonly known as "blues," and characteristic of the Palæarctic and Nearctic regions, with species in N. India, S. Africa, Chili and New Zealand.

We now come to a point of considerable interest. Taking the genera peculiar to Australia, we find that the greatest actual number is possessed by Queensland and the least by Tasmania. By far the greatest proportional number (excluding Queensland which is naturally rich in immigrant forms) is possessed by West Australia and the least by S. Australia and Tasmania. In the case of the latter only 2 out of its 10 genera are Australian, whilst in W. Australia there are no fewer than 6 out of 11.

The butterfly fauna of Tasmania is thus poor in quantity and, so far as genera are concerned, most largely composed of those not peculiar to Australia whilst at the same time it has, doubtless owing to its isolation, developed a certain number of peculiar species.

(2.) *Coleoptera.*—Amongst many who have worked at this group we may perhaps especially mention the names of Messrs. Masters, Blackburn, Macleay, Olliff, and Sloane. To the first named we owe a valuable catalogue of Australian and Tasmanian forms, whilst during the past few years Mr. Blackburn has added immensely to our knowledge of the Coleopteran fauna of the various colonies and especially of S. Australia.

On the continent of Australia and Tasmania there are at present known to exist the representatives of 67 families of which 44 are found in Tasmania. These contain* 1644 genera of which 298 are found in Tasmania. The total number of species is 7847 of which Tasmania has 521. Of the genera, 42, containing 395 species, are peculiar to Tasmania as compared with the mainland. Taking the different families we may note the following points of importance :—

* These and other numbers are computed from published records available up to November, 1891. The numbers for Tasmania would be not inconsiderably increased were all forms collected described and it is important that this should be done.

The *Cicindelidæ* are entirely absent, so far as yet known. This is of interest because, though not numerically strong in the whole region, genera of this family are found in all the other colonies and it is one of those which shows a resemblance between the Australasian and S. American faunas, *Tetracha* being a characteristic S. American form, with 11 species in Australia, whilst another, *Megacephala*, has 2. A third genus, *Distypsidera*, occurs in Queensland and not further south than the northern part of New South Wales, whilst it is also represented in New Zealand. These three genera are not yet known from Victoria or Tasmania, and the family is best represented in Queensland and West Australia, poorly in S. Australia and Victoria, and not at all in Tasmania.

The *Carabidæ* have, in Australia and Tasmania, 169 genera and 1038 species. Of these 30 genera and 49 species are found in Tasmania of which 6 and 33 respectively are peculiar to the island. The Australian genus with the greatest number of species is *Carenum;* but this has only one in Tasmania and that is also found in Victoria. The poverty of Tasmania is only slightly greater than that of Victoria from which, as yet, only two species of *Carenum* are recorded whilst elsewhere on the continent the genus is well represented. The important Australian genus *Promecoderus* is, however, fairly well represented in Tasmania by five species peculiar to the island, Victoria having nine. This genus belongs especially to the south and east parts of Australia and it is not thus surprising to find it well represented in Tasmania whilst the isolation of the latter has resulted in the production of peculiar species. It has closely allied genera in Chili and Patagonia.

The two large Australian genera—*Silphomorpha* and *Adelotopus*—have each only one species in Tasmania though both are widely distributed from West Australia to Queensland. The first has 9 and the second 4 species in Victoria of which none pass over the Strait whilst the single species of *Adelotopus (A. hæmorrhoidalis)* is identical with a South Australian form. *Notonomus* again has only 2 species in Tasmania whilst in Australia it has 58 of which 12 are found in Victoria. On the other hand, *Laocordaria* is well represented by 3 species peculiar to the island, there being 3 Victorian and New South Wales and one Queensland species of the genus described.

The genus *Trechus* is curious in having its 3 species, 1 peculiar to Tasmania and 2 to Queensland; *Loxandrus* has 3

species in Queensland and 1 in Tasmania, whilst *Scopodes*, *Harpalus*, and *Chlænioideus* have species in Tasmania but not in Victoria. With these exceptions all the Tasmanian genera are common to Victoria.

Of genera common to Australia and New Zealand, Tasmania does not possess many representatives. *Homalosoma* has no species in Tasmania, *Mecodema* has 1, *Dicrochile* has 1 common to Tasmania and Victoria and *Scopodes* has 2.

The family *Hydrophyllidæ*, with 15 genera and 45 species, is mainly confined to the north east of the continent, having 1 species of *Hydrophilus* extending south to Victoria and New South Wales and being represented by 1 species and genus (*Cercyon dorsalis*) in Tasmania.

The *Staphylinidæ* are well represented in Australia, which, together with Tasmania has 69 genera and 204 species. Of these only 9 genera and 12 species are found in Tasmania. Only 1 genus is confined to Tasmanian but 11 out of the 12 species are peculiar, 1 species (*Oxytelus discipennis*) being identical with a New South Wales form. Nine out of the 12 genera are common to Victoria and widely distributed over the continent, whilst two do not occur in Victoria but are found, one in Queensland and one in the latter and New South Wales.

The *Trichopterygidæ* are a very small family with only 2 genera in Australia and Tasmania, each having 1 species only. *Actinopteryx australis* is peculiar to West Australia and *Ptilium simsoni* to Tasmania. None are as yet recorded from the other colonies.

The *Phalacridæ* are represented by 1 genus and species only—*Litochrus brunneus*—confined to the island.

In the *Cucujidæ* we have a family comprising in Australia and Tasmania 16 genera and 46 species and well represented in Tasmania where there are 11 genera and 18 species—a large proportion when compared with other families. One genus is peculiar and 6 species. *Ancistria retusa* is found in Queensland and Tasmania, *Prostomis atkinsoni* in Victoria and Tasmania, two forms—*Cryptomorpha triguttata* and *Prostomis cornutus*—in South Australia and Tasmania, three forms—*Isaphes moerosus*, *Læmophlæus bistriatus*, and *L. testaceus*—in New South Wales and Tasmania whilst others such as *Platisus obscurus* and *Brontes militares* are widely distributed.

The *Lucanidæ*, or stag beetles, form an attractive group the members of which have hence been largely collected

almost all over the world. The family is moderately well represented in Australia by 46 genera and 66 species of which Tasmania has 6 genera and 13 species, 1 genus being peculiar to it and, as usual, a large proportion, 10, of species.

There are four genera worthy of note so far as Tasmania is concerned. *Lamprima* is represented by a form common to Tasmania, Victoria, and New South Wales and is a genus of wide distribution throughout Australasia, occurring in all the colonies and beyond the continent in Lord Howe Island, Norfolk Island and in New Guinea. It appears to be represented in Chili by the genus *Streptocerus*. *Lissotus* is common to Australia and New Zealand and is remarkably well represented in Tasmania. In Mr. Master's list 12 species are given of which no fewer than 8 are recorded from Tasmania. One or two of these, such as *L. cancroides*, are probably common to Victoria. Owing to the fact that *Lissotus* is also a New Zealand genus its strong development in Tasmania is worthy of note. The third genus is *Syndesus* which is found in Australia, New Caledonia and tropical South America, the species *S. cornutus* being common to Australia and Tasmania. The fourth genus—*Ceratognathus*—found also in New Zealand, is represented in Tasmania by 1 species—*C. niger*—common to it and the mainland.

The *Scarabæidæ*, including the forms commonly known as *Lamellicorns*, are represented in Australia and Tasmania by 139 genera and 705 species. Tasmania has 22 genera and 53 species, 3 of the former and 43 of the latter being peculiar. Nineteen genera present in the Island are widely distributed on the continent and the three best represented are *Onthophagus* with 8 species, 3 being peculiar and the others common to Victoria; *Liparetus*, with 5 species, one common to South Australia, the rest peculiar, and the large genus *Heteronyx* of which some 160 species are described from Tasmania and Australia and 10, all peculiar to it, from the former.

In the *Buprestidæ* the Australian region is peculiarly rich, there being now recorded 36 genera and 324 species of which 7 genera and 14 species are recorded from Tasmania, 2 genera and 9 species being peculiar. The species, except *Conognatha navarchis* and *Discoderes tasmanicus*, all belong to widely distributed genera and 5 of them are common to Victoria. The most characteristic Australian genus is *Stigmodera* of which 234 species are recorded from the continent and only 6 from Tasmania, of which one is peculiar to King Island. The family *Buprestidæ* is another of those which

show a curious relationship between Australia and South America and it is thus worth noticing whether this relationship is indicated in the Tasmanian fauna. The genus *Stigmodera* is closely allied to certain South American genera and, as we have seen above, this genus is remarkably poorly developed in Tasmania. The genus *Curis* again is found in Australia and Chili. It has 13 species on the Australian continent scattered over Western and South Australia, Victoria, New South Wales and Queensland, but is not recorded from Tasmania. *Acherusia*, again, is a genus found in Brazil and Tasmania but has no representative in Tasmania. It must also be noted in connection with this point that New Zealand is remarkably deficient in this family, Mr. Sharp, in his list of New Zealand *Coleoptera*, only recording two minute and obscure forms.

Mr. Wallace, in dealing with the *Buprestidæ*, says:—"Here we have a striking contrast to the *Cetonidæ* and we can hardly help concluding that as the latter is typically a tropical family so the present family although now so largely tropical had an early and perhaps original development in the temperate regions of Australia spreading thence to temperate South America as well as to the tropical regions of Asia and Africa." And again, "these resemblances (*i.e.*, between Australia and South America) may probably have arisen from intercommunications during the warm southern period when floating timber would occasionally transmit a few larvæ of this family from island to island across the Antarctic Seas. When the cold period returned they would spread northwards and become more or less modified under the new physical and organic competition to which they were subjected."

These quotations show that Mr. Wallace is of opinion that the *Buprestidæ* spread southwards from Australia during the period when, doubtless, the projecting southern parts stretched still further to the south than now they do and formed an intermittent connection with Antarctic lands, across which, postulating a warmer climate than now exists, animal life might pass and reach South Africa and South America. If the distribution of the *Buprestidæ* has taken place in this way then it is a curious fact and one very difficult of explanation that the two southernmost portions of the Australian region—Victoria and Tasmania on the one hand, and, more noticeably still, New Zealand on the other—are just those parts which are poorest in representatives of the family.

The *Dascillidæ* form a small family with only 3 genera which have a remarkable distribution in Australia. One genus— *Dascillus*,—with only one species (*D. brevicornis*) is recorded only from Queensland; the second, *Scirtes*, with only one species (*S. exoletus*) from West Australia and the third, *Helodes*, with 3 species, is confined to Tasmania, (*H. atkinsoni*, *australis*, and *maculatus*.)

The *Lymexylonidæ* is another small family with a very limited distribution in Australia, there being only one genus and species (*Atractocerus kreuslerœ*) confined to South Australia and another (*Lymexylon australe*) confined to Tasmania.

The *Tenebrionidæ* are a large family, with 127 genera and 530 species in Australia and Tasmania of which 24 genera and 39 species are found in the latter, 4 genera and 32 species being peculiar. The genus *Cotulades* is divided between Tasmania, with 2 species, (*C. fascicularis* and *funerosa*), and Northern and Western Australia which have one species in common (*C. leucopsela*). The great majority of the species, though peculiar to the Island, are representatives of genera widely distributed on the continent, most of the larger genera having representatives in Tasmania.

The *Pythidæ* are represented by one genus and species confined to Tasmania (*Lissolema hybridum*).

The *Curculionidæ* form a large and important family in Australia, which, with Tasmania, has 316 genera and 1274 species, with 42 genera and 77 species in the latter to which 8 genera and 73 species are peculiar. This family is thus the largest in point of numbers in both Australia and Tasmania. A very large number of forms have been described from Western Australia and very few from Victoria which is only credited with, as yet, 31 genera and 58 species, a considerably lesser number than is recorded for Tasmania. Of the 38 genera common to the latter and the Continent, not one-half are recorded for Victoria; in fact New South Wales has 24, Queensland 21, South and Western Australia each 18 and Victoria 16 genera common to Tasmania. Of species, 4 are common to Victoria and Tasmania, 2 to New South Wales and Tasmania, 4 to South Australia and Tasmania and no no fewer than 73 are peculiar to the Island, though when Victorian forms are well described this number will doubtless be much lessened.

We now come to the important family *Cerambycidæ* which includes the Longicorn beetles. These, like the Lamellicornes, are attractive insects and have hence been widely

collected. Australia and Tasmania together are now credited with 216 genera and 587 species, of which the latter has 34 genera and 43 species, there being 4 genera and 23 species peculiar.

The *Cerambycidæ* are divided into three sub-families, the Prionides, Cerambycides, and Lamiides, and in different regions the proportions of the three groups vary. Speaking generally, it may be said that the Cerambycides increase in temperate and decrease in tropical parts whilst the reverse is true of the Lamiides. The Prionides again are proportionately more numerous in temperate parts. Thus, according to Wallace's calculation, the Cerambycides are more numerous than the Lamiides in the Nearctic and Palearctic regions in the proportion of 12 to 9. The same author gives the proportion of the Cerambycides and Lamiides in the Oriental and Ethiopian regions as 6 to 11 and in the Australian as 5 to 6. Now, if we exclude the Austro-Malay portion of the Australian region—that is a large portion of its tropical parts—and take simply Australia and Tasmania, we find that the proportion is reversed and becomes 5 to 4. The following table indicates the proportional representation of the three sub-families in the various parts of the Australian region :—

	Prionides.	Cerambycides.	Lamiides.
Australia and Tasmania	7	52	41
North Australia	5	25	70
Queensland	4	42	54
New South Wales	5	62	33
Victoria	5	70	25
South Australia	4	63	33
Western Australia	6	55	40
Tasmania	10	76	14

We thus see that whilst in the northern region, that is the more tropical, the Lamiides preponderate; as we pass south into temperate parts the Cerambycides gradually increase until their maximum proportion is reached in Tasmania where they form 76 and the Lamiides only 14 per cent. Though the Prionides show no such regular increase towards temperate parts, it is noticeable that they are most numerous proportionately in Tasmania whilst it is worthy of note also that the proportional distribution of the three sub-families in

West Australia is very closely similar to that of their distribution in Australia as a whole.

Of important genera, *Cnemoplites* has one species (*C. australis*), *Phoracantha* has 2, one widely distributed and one peculiar to the island ; and *Pseudocephalus*, a genus represented in Chili, has one species in Tasmania another in Victoria and a third in W. Australia. In the Lamiidæ, *Zygocera*, which, again, is represented in Chili, has one species (*Z. cænosa*) common to Tasmania, Victoria, S. Australia and New South Wales, whilst the large genus, *Symphyletes*, is unrepresented in Tasmania and has only one species in Victoria.

The *Chrysomelidæ* form a family well represented and widely distributed in Australia which, together with Tasmania, has 124 genera and 984 species, Tasmania having only 15 of these genera and 59 species, there being no genera peculiar to the island but 45 species. The large genus *Elaphodes*, with 96 species, has only 3 in Tasmania which are peculiar to it. *Tomyris* with 6 species has 3 peculiar to Tasmania, 1 to New South Wales, 1 to Queensland and 1 to North Australia, with no representative recorded from Victoria. The extensive and well-distributed genus *Paropsis*, with 270 species in Australia and Tasmania, has 27 in the latter, of which all but 3 are peculiar and of these 2 are common to Victoria and 1 to S. Australia.

Mollusca.

In this group we will deal only with the land and fresh-water forms. Of Australian workers on Mollusca we may mention especially the names of Professor Tate and Messrs. Cox, Brazier and Hedley, whilst in recent years Mr. Edgar Smith, of the British Museum, has published an important list of Australian fresh-water shells. In Tasmania we owe much to the labours of Messrs. Legrand, Petterd, Johnston and Beddome, and in New Zealand to Professor Hutton. We are still much in need of a monograph dealing with the soft parts of the animals as well as with the shells. A few of our workers, such as Messrs. Hedley, Cox, Johnston and Petterd have done something in this direction but this branch of the work has been too much neglected.

(1.) *Land Mollusca.*—In land shells Tasmania is comparatively rich and its forms have been well collected and described. We can scarcely say the same of Victoria but

descriptions of Victorian forms, chiefly by Professor Tate, enable us to institute some interesting comparisons between Tasmania and the other colonies. In Tasmania the genus *Helix* (as at present recognized) is represented by 64 species of which no fewer than 59 are peculiar to the island. Of the other eight, five *(H. m'coyi, stanleyensis, otwayensis, tamarensis, and exoptata)* are common to Tasmania and Victoria, one only *(H. pictilis)* to Tasmania and W. Australia, one only *(H. hobartia)* to Tasmania, Victoria, and S. Australia, whilst one *(H. morti)* has a wide distribution from W. Australia to New South Wales. Thus Tasmania has in all 7 species common to Victoria. If now we take the results given by Professor Tate for the Land Shells of Victoria we find that the latter is credited, as yet, with 18 species of Helix—a very poor record as compared with the 64 of Tasmania, an equal number of New South Wales forms and more than 40 of S. Australia. Of the Victorian 18, 8 are peculiar to the colony and of the other 11 it has 7 in common with Tasmania, 4 with New South Wales, 4 with S. Australia, and 1 with W. Australia It has none common to itself and only one other colony except in the case of Tasmania where there are 5. We find also that the genus *Helicarion* is represented in Tasmania by two species *(H. verreauxi* and *milligani.)* The former is widely distributed, being found also in the islands in Bass Straits and is common to Victoria where it occurs widely distributed south of the Dividing Range, being recorded from C. Otway, Fernshaw, Gippsland and as far east as Sale. A second Victorian form *(H. atramentaria)* is recorded only from Westernport. Neither Victoria nor Tasmania have any species in common with New South Wales. The genus *Bulimus* is represented by two species in Tasmania, one of which *(B. dufresni)* is very widely distributed and occurs on the islands in Bass Straits, whilst a second, which has been described as *B. Tasmanicus*, appears to be identical with a fossil from, *B. gunni*, found in Kent Island and in the 'yellow limestone' of Hobart. The genus *Succinea* is represented by two species in Tasmania of which one *(S. legrandi)* is peculiar to it, whilst another *(S. australis)* is widely distributed, occurs in the islands of the Straits and passes over to the mainland where it occurs in Victoria and S. Australia. The genus Truncatella is, so far as Tasmania is concerned, confined to the islands of Bass Straits where three species are probably present, living between tide marks on the sea shore *(T. scalarina, tasmanica,*

and *marginata.)* It is these shells which, together with those of *Elenchus irisodontes* are used in making the well-known necklaces.

With regard to slugs, comparatively little is known at present. It is, however, worth noticing that a peculiar genus, Cystopelta, with one species *(C. petterdi)* described by Tate, has since been taken in Victoria at Ballarat and just across the border at Mt. Kosciusko.

(2.) *Fresh Water Mollusca.*—In these there are the representatives of 9 families in Australia and Tasmania, viz. :—Lymnæidæ, Melaniadæ, Paludinidæ, Valvatidæ, Neritidæ, Rissoidæ, Assiminidæ, Cycladidæ, and Unionidæ. Of these three, the Melaniadæ, Paludinidæ, and Neritidæ, are absent from Tasmania. Of the three families absent from Tasmania, the Paludinidæ and the Neritidæ are also wanting in Victoria, whilst of the third, the Melanidæ, which is only at all well represented in Queensland (10 species), Victoria has only a single species.

The 7 families named contain altogether in Australia and Tasmania 25 genera with 213 species. Both in number of genera and in species Tasmania is ahead of any other division of the region, containing 17 genera with 55 species the next being Queensland with 12 genera and 45 species, then New South Wales with 13 genera and 37 species, and then, very closely equal, Victoria with 11 genera and 25 species and South Australia with 11 genera and 26 species.

The genus Lymnea has 4 species of which one *(L. launcestonensis var. papyracea)* is found in Victoria and South Australia; two are peculiar and one is common to South Australia only.

Bulinus is well represented by 19 species, of which, as at present recorded, all save one *(B. pyramidata)* are peculiar, that one being common to Victoria. Australia and Tasmania have between them 68 species of this genus which is well represented in all the Colonies and there are comparatively few not peculiar to a single Colony.

Ancylus has 3 peculiar species in Tasmania and only 2 on the Continent, of which one *(A. australicus)* is common to Victoria, South Australia and Queensland and another *(A. smithi)* is peculiar to New South Wales.

The most interesting freshwater mollusc of Tasmania is however *Gundlachia petterdi* described by Johnston from near Launceston and again by Professor Tate from Mount Lofty, South Australia. This is, so far as yet known, the only

representative in the Australasian region of a genus which is elsewhere found in South America and Cuba.

Planorbis has 5 peculiar species, but the genus is not represented in Victoria, being recorded however from New South Wales, South Australia and Queensland.

Segmentina is absent in Tasmania and has only 2 species in Australia, one confined to Victoria and one to New South Wales.

The genus Melania, as before said, is most strongly developed in the northern parts of the Continent, Queensland having 10 species, New South Wales 3 and Victoria and South Australia only 1 each. It appears to be quite absent from both Western Australia and Tasmania, the one species which spreads far south (*M. balonnensis*) being common to Queensland, New South Wales, Victoria and South Australia.

Paludina again is a genus scarcely found save in the northern parts and is wanting both in Victoria and Tasmania.

In the Rissoidæ the genus Bithynia has 7 species all peculiar whilst Victoria and New South Wales have only one each. Amnicola again has 7 peculiar species and is not represented on the Continent.

The family Assiminidæ is of interest inasmuch as the genus *Assiminea* is represented in Tasmania, Western Australia and Queensland and again in New Zealand whilst it is also found in Europe, India, and Polynesia.

In the Lamellibranchs 4 out of 5 genera found in the Australian region have representatives in Tasmania. These are—Sphærium, with one peculiar species; Pisidium with 2 peculiar species; and lastly Unio. The species of this genus which have been described are not altogether satisfactory and at present Tasmania may be credited with one, *Unio moretonicus*, which is probably a variety of *U. australis* and common to Tasmania and Australia.

The fifth genus Mycetopus is only recorded from Northern Australia where it has one species (*M. rugatus*), and of this Edgar Smith points out that, "It is remarkable that Australia and South America should possess species so much alike as *M. siliquosus*" and the North Australian form.

In contrast with the community of land shells existing between Tasmania and Victoria, it is important to notice the marked absence relatively of such a community in freshwater forms. Out of more than 50 species in Tasmania only 4

are common to Victoria and in addition to these one more (*L. huonensis*) is described by Professor Tate as common to South Australia, while one (*Pomatiopsis striatula*) appears to be common to Western Australia.

Taking the land and freshwater mollusca, the following are the main points of interest which they present:—

(1.) The large development of these forms, especially aquatic ones, in Tasmania compared with the Colonies on the mainland. This is in keeping with the usual large number of these forms found on islands throughout the world.

(2.) The remarkable agreement in generic distribution of land forms between Tasmania and Victoria.

(3.) The extensive community in species of land forms between Victoria and Tasmania and the slight community between either of these two and the other Colonies.

(4.) The striking lack of community in species of aquatic forms between Tasmania and any other Colony on the mainland.

Pisces.

In the group Pisces we will again deal only with freshwater forms.

In addition to Dr. Günther's great reference work on fishes we have several excellent lists published dealing with the fishes of the Australasian region. Prominent amongst these is Sir Wm. Macleay's catalogue, whilst in New Zealand Professor Hutton has published a catalogue of their fishes and, recently, Mr. A. H. S. Lucas has published a census of Victorian fish and Mr. Johnston a list of Tasmanian species.

From the rivers and fresh waters of Australia and Tasmania representatives of 14 families have been recorded, viz., Gadopsidæ, Trachinidæ, Mugillidæ, Siluridæ, Haplochitonidæ, Galaxidæ, Osteoglossidæ, Percidæ, Pristipommatidæ, Sparidæ, Cyprinidæ, Clupeidæ, Salmonidæ, Murænidæ, together with genera belonging to the Dipnoi and Cyclostomata.

Two of these—the Osteoglossidæ and the Dipnoi—are confined to Queensland, each of these being represented by one species. It is important to note that both groups are confined in their distribution to tropical Australia, tropical South America and tropical Africa. *Osteoglossum leichardti*,

the Barramundi of the Dawson and other rivers, represents the former, whilst the remarkable *Ceratodus forsteri* of the Burnett and Mary Rivers is the sole representative of the latter group.

Of the remaining 13 families 9 are represented in the freshwaters of Tasmania which has also two genera of the Cyclostomata.

In a paper read before this Section at the Melbourne meeting dealing with the Distribution of the Vertebrata of Victoria, Mr. A. H. S. Lucas pointed out for the first time how, in different vertebrate groups, the dividing range formed a barrier separating a northern from a southern group of forms and that in the various groups, but especially in the case of reptilia and fishes, the latter and the Tasmanian faunas were remarkably similar.

The facts brought together in this paper are strongly in favour of this interesting generalisation of Mr. Lucas and we may, I think, go further still and find strong support, as will be seen later, in favour of the separation of a Euronotian from an Eremian region, as proposed by Professor Tate mainly on botanical evidence.

To return to the fishes; if we take the 9 families represented in Tasmania, we find that they are all common to Victoria, leaving 4 which are present in the latter but absent in the former. These are (1) the Pristiopommatidæ, with two important genera—*Therapon* (Murray Perch) and *Murrayia* (Murray Bream)—which are found only north of the divide in the Murray River system. (2.) The Siluridæ, represented in northern Victoria solely by the Catfish (*Copidoglanis tandanus*) of the Murray River system. (3.) The Cyprinidæ, with only one genus and species—*Neocarassius ventricosa*—recorded only from the Saltwater River. Apart from the fact that this is scarcely a freshwater fish, its existence may be regarded as extremely doubtful. (4.) The Clupeidæ, with *Chatoessus richardsoni*, from the Murray. That is, with one very doubtful exception, all the families found in Victoria south of the Divide are also found in Tasmania.

So far as genera are concerned, and including the Cyclostomata, Tasmania has 14 and Victoria 21. Of the latter, 7 are only found north of the Divide and are absent from Tasmania, the remaining 14 belonging to South Victoria are all, with one exception (*Neocarassius*) common to Tasmania

which has only one genus (*Haplochiton*) not represented in Victoria.

The genera of especial interest, from the point of view of their distribution, are the following :—

Lates (brackish water perch) has one species found only in the Anson River in N.E. Tasmania, the same species existing in Victoria. The genus has representatives in the Nile and Rivers of India and China.

Aphritis has one species in Tasmania, the same in Victoria, and two others in Patagonia.

The family Haplochitonidæ are confined to temperate South America, Victoria, Tasmania, and New Zealand. One genus—*Haplochiton*—is found only in Tierra del Fuego, the Falkland Islands, and Tasmania ; the second—*Prototroctes* (freshwater herring)—only in South Victoria, North Tasmania and New Zealand.

Galaxias (Trout) is found only in the Rivers of South America, ranging from Tierra del Fuego as far north as Chili, in the rivers of South Victoria and South New South Wales, and in the rivers of Tasmania. One species (*Galaxias attenuatus*) is common to South Victoria, Tasmania, New Zealand, the Chatham and Falkland Islands, and Chili. This genus is the most widely spread of any freshwater fish in Tasmania, from which, including King Island, 7 species are described, two (*G. occellatus* and *delicatulus*) being found in the latter and in South Victoria but not in Tasmania itself.

Aganostoma (mullet) has two species (*A. diemensis* and *lacustris*) common to South Victoria and Tasmania. The distribution of this genus is remarkable, its species being only elsewhere found in the fresh waters of the West Indies, Central America, New Zealand, Australia, the Celebes and Comoro Islands.

Gadopsis (blackfish) is confined to Australia and Tasmania, being found in the rivers of New South Wales, Victoria, South Australia and North Tasmania. One species (*G. marmoratus*) is common to the latter and the mainland.

In the Cyclostomata or Lampreys two genera with one species each are recorded from Tasmania, viz., *Mordacia mordax* and *Geotria allporti.* In South Victoria the former is found together with a species of the genus Geotria (*G. australis*) which also occurs in South Australia. This genus also is represented in Chili.

There is thus a striking community in the fresh-water fish faunas of Tasmania and South Victoria and at the same time a remarkable affinity between (1) the south-eastern part of Australia including Tasmania, (2) New Zealand and (3) temperate South America.

Amphibia.

In New South Wales Fletcher has recently revised and increased the list of Amphibia and Lucas has increased the scanty record of Victoria from 9 to 16 species, but notwithstanding this it is as yet impossible to compare the amphibian faunas of the different colonies satisfactorily. Tasmania is credited with 9 species. Two families are certainly represented, the Cystignathidæ and Hylidæ, whilst possibly a *Pseudophryne* is present. If this be so then Tasmania may be credited with a third family, the Bufonidæ. In the Cystignathidæ two genera are represented—*Lymnodynastes*, with two species (*L. peronii* and *tasmaniensis*), common to Victoria and the eastern coastal district of Australia and *Crinia*, with two species (*C. tasmaniensis* and *lævis*), of which one is doubtfully represented in Victoria. A third genus common in Victoria and New South Wales is unrecorded from Tasmania, viz., *Heleioporus*.

The Hylidæ have one genus present, *Hyla*, with three species (*H. peronii*, *aurea*, *ewingii*), whose presence is well established and which are common to South Australia, Victoria and the east coast of Australia, and two more doubtful ones (*H. krefftii* and *verreauxii*).

There are no special features in the Amphibian fauna of Tasmania apart from its close relationship to that of Victoria and its community of such families, genera and species as it does possess with those of the south-east and east coastal districts of the continent.

So far as any connection with South American forms is concerned *Pseudophryne*, allied to South American genera, is only doubtfully recorded and the *Bombinatoridæ*, which by the presence of *Leiopelma* in New Zealand indicate an alliance between the latter and South America, are entirely absent. The Hylidæ, which form especially a neotropical family, are represented by perhaps 4 species of the genus *Hyla* which is not only distributed through every region save the African but has also many more representatives in the north-east part of Australia than in Tasmania. The Discoglossidæ, a family with allied genera in Australia and Chili, are absent

from Tasmania whilst as negative evidence may be noted the absence of the genus *Rana* in both South America and Australia.

Reptilia.

In this group, so far as our present knowledge goes, there are three important facts to be noticed. First, that Tasmania is remarkably poor in representatives of this group; second, that it does not contain a single genus or even species peculiar to itself, nor even a genus especially well developed; and third, that such forms as it does possess are all found in South Victoria, whilst, as Mr. Lucas pointed out in the paper above referred to, the forms characteristic of North Victoria are remarkable for their absence from Tasmania.

(1) *Ophidia.* Of the four families represented in Victoria, viz., Typhlopidæ, Dendrophidæ, Pythonidæ and Elapidæ, only the latter is found in Tasmania. At the same time only one of the three first is represented in South Victoria and that by a single species. Out of 7 species found in South Victoria (*Typhlops bicolor*, *Pseudechys porphyriaca*, *Diemenia superciliosa*, *Hoplocephalus curtus*, *superbus*, *flagellum*, and *coronoides*), 5 are common to Tasmania. Of the 16 species found in North Victoria only two (and these widely distributed forms) are common to Tasmania (*Diemenia superciliosa* and *Hoplocephalus curtus*). All Tasmanian species, as is well known, are venomous and it is therefore interesting to note that in Victoria non-venomous forms, such as the carpet snake (*Morelia variegata*), the blind snakes (*Typhlops*), &c., are far more abundant in the northern than the southern parts; in fact, as Mr. Lucas says, "the harmless snakes are characteristic of the northern and rare visitants of the southern division of Victoria."

Beyond the comparison between South Victoria and Tasmania, instituted by Mr. Lucas, a suggestive one may be made by comparing the Ophidian fauna of North Victoria with that of South Australia as given by Mr. Zietz. So far 9 genera are recorded from the former of which 7 are in common with the latter, whilst out of 16 species in North Victoria 10 are common to South Australia and only 4 to South Victoria (*Typhlops bicolor*, *Diemenia superciliosa*, *Pseudechys porphyriacus*, *Hoplocephalus curtus*). That is, so far as Ophidia are concerned, Tasmania and South Victoria on the one hand, and North Victoria and South Australia on the other, are closely allied. At the same time the two groups are sharply marked off from each other.

In other groups of reptiles all that can be noted is the entire absence of Chelonia, of which two forms (*Chelymys macquaria* and *Chelodina longicollis*) are found in Victoria (the latter only in the southern part), and the poverty of the island so far as yet recorded in Lacertilia. Amongst others *Hinulia whiteii* and *H. lesueri* are present in South Victoria and Tasmania but absent from North Victoria.

Aves.

So far as our present purpose is concerned, two works, the List of Australian Birds by Dr. Ramsay and the List of Tasmanian Birds by Colonel Legge may serve for reference. In Dr. Ramsay's list no distinction is made between Victorian and S. Australian birds and though, naturally, the two colonies have the great majority in common they have not all, and to workers in either colony a separate list, or, at any rate, some sign to indicate the forms not common to both would have been of interest and value. I am much indebted to my friend, Mr. A. J. Campbell, whose practical acquaintance with Victorian birds and their modes of life and nesting is probably greater than that of anyone else, for his kind assistance in informing me of those which are and those which are not common to both colonies as well as for other information, the results of his own observations.

As might have been expected, Tasmania differs chiefly from the mainland, so far as birds are concerned, in two points: (1) the smaller number of forms and (2) the absence of certain characteristic Australian forms. Australia and Tasmania have between them 285 genera and 761 species. Tasmania alone has 129 genera and 203 species. Of the latter, some 21 only are peculiar to the island. The relationship with other colonies may be estimated by the fact that out of its 203 species it has 168 in common with Victoria, the same number in common with New South Wales, 160 with S. Australia, 139 with Queensland and 120 with W. Australia

Seeing how apparently easily birds could pass over to Tasmania from the mainland, taking advantage of the chain of islands to the east side of Bass Straits, it is almost surprising to find even 21 species peculiar. On the west side there is no such close connection and out of 69 species of birds collected during a visit of the Victorian Field Naturalists' Club to King Island, 14 were comprised in the 21 peculiar to Tasmania whilst only 1 was not a Tasmanian species. On

the east side in Kent Group, out of the 54 species collected only 4 were peculiarly Tasmanian, the rest, save 2, were common to Victoria and Tasmania, these two being Victorian. Of the peculiar species, *Alcyone diemensis* is the only representative of the genus Alcyone belonging to the kingfisher family which is found in Tasmania.

In the Pardalotes, the 40-spotted diamond bird *(P. quadrangintus)* is peculiar to Tasmania, ranging northwards into King Island.

The ground thrush, *Geocinchla macrorhyncha*, may be noted as a species peculiar to Tasmania and belonging to a widely dispersed genus. The latter extends from E. Siberia, through Burmah to India and Ceylon and thence through the Malay Archipelago to Australia, where are 3 species—*G. heinii* of N. Australia and Queensland, *G. lunulata* of New South Wales, Victoria, and S. Australia and *G. macrorhyncha* of Tasmania.

The crow-shrikes are represented by two species, of which one *(Strepera arguta)*, the Hill crow-shrike, is peculiar to Tasmania, the other, the sooty crow-shrike *(E. fulginosa)* is common to Tasmania and Victoria.

The genus Gymnorhina, which includes the common Australian piping crow-shrike, is represented by one peculiar species, *G. organicum*, the Tasmanian crow-shrike, whilst the two Victorian forms do not pass across the Straits.

The genus Cracticus is only represented by one species, *C. cinereus*, the Butcher bird.

Of Robins, Tasmania has the pink-breasted, the scarlet-breasted, the flame breasted and the dusky robin, the latter belonging to a genus, Amaurodryas, confined to Tasmania and Victoria.

One of the most interesting forms in the great Acanthiza peculiar to the island, and for the reception of which Colonel Legge has made a new genus—Acanthornis. Mr. R. B. Sharpe, however, places it in the genus Sericornis. In the characteristic Australian family the Meliphagidæ, or honey-eaters, Tasmania possesses the wattle bird *(Acanthochæra inauris)*, the strong-billed honey-eater *(Melithreptus validirostris)*, and the black-headed honey-eater *(M. melanocephalus)*.

Among the parakeets *(Platycercus)*, which have 6 species in Victoria, only 2 are found in Tasmania, the common yellow-bellied parakeet *(P. flaviventris)* being common in Tasmania but ranging northward into King Island, the Kent Group and Victoria.

It is, however, the birds which are absent quite as much as those which are present which it is important to note.

In the first place there is no Struthious bird now existing in the island; in Queensland only there is found the Cassowary (*Casuarius australis*), and all over Australia one species of Emu (*Dromaius novæ-hollandiæ*), whilst a second species of the latter (*D. irroratus*) occurs in North, South, and West Australia, but is absent from the eastern colonies. Formerly an Emu existed in Tasmania but it is now apparently quite extinct, the date of its extinction being uncertain.

On the continent are relics of a once greater development of Struthious birds allied to the extinct Dinornis of New Zealand. No traces of these are discovered in Tasmania.

In the undoubtedly greater past and present development of Struthious birds in the north than in the south-east part of Australia (including Tasmania) we have again an instance of alliance between the former rather than between the latter and New Zealand.

Amongst the Carinatæ there are three notable Australian forms wanting in Tasmania. The first of these are the bower birds belonging to the family Paradiseidæ, and of which two are present in Victoria,—one, the satin bower bird (*Ptilonorhynchus violaceus*), in the south east, the other, the spotted bower bird (*Chlamydodera maculatus*), in the north west. It is worthy of note that the eastern species is common to New South Wales but not to South Australia, whilst the western species is common to the latter.

The second form is the lyre bird, of which three species are known on the continent. One (*Mœnura superba*) confined to New South Wales; another (*M. alberti*) in South Queensland and New South Wales, and a third (*M. victoriæ*) only found in Gippsland in S.E. Victoria. It is rather strange that neither of these forms, for the existence of which Tasmania seems admirably adapted, should have passed across from the continent and the only possible explanation must be found in the supposition that Tasmania became separated off before they existed in Victoria.

The third of the three forms are the Megapodidæ or mound-builders, and their absence is more easy to understand. There are three species on the mainland; one, *Tallegallus lathami*, of Queensland and New South Wales; a second, *Megapodius tumulus*, of Northern Australia, and a third, the Mallee-hen or Lowan (*Leipoa occellata*) of West Victoria,

S. and W. Victoria, and New South Wales. These birds are distinguished by their habit of forming a large mound of sand and vegetable material in which the eggs are laid and incubated. The mallee-hen is found in Victoria in the dry mallee scrubs in the western part of the Colony and not in the south-east parts and hence it is not surprising to find it absent from Tasmania, the physiographical features of which are scarcely suited to its habits.

Finally, with regard to birds, a note by Mr. A. J. Campbell is worth quoting, as it bears upon a point which will be referred to again in dealing with the mammalia. He says, " it appeared to me that some of those species of birds common to Australia and Tasmania were larger in the latter country than in the former, notably the thrushes and some of the honey-eaters. The eggs also give greater dimensions. The only hypothesis I can advance for the difference is climatic influence."

Mammalia.

In this group Tasmania presents to us a fauna which may perhaps be best described as a condensation of most that is most noteworthy in the Australasian region. We have in Tasmania representatives of the three great mammalian groups, the Prototheria, Metatheria and Eutheria. To a biologist the interest of these three groups so far as Australia is concerned is in the inverse ratio of their stage of development and numerical proportions.

(1.) The Eutheria are only represented in Tasmania by two cosmopolitan groups, the Cheiroptera and the Rodentia. Of the former but little is known. The following Rodentia are recorded in Higgins' and Petterd's list of Tasmanian vertebrata:—

Mus tetragonurus, pachyurus, castaneus, velutinus, setifer, fuscipes, griseo-ceruleus, leucopus, variabilis, simsoni.
Hydromys chrysogaster.

(2.) Prototheria.—This group includes only two families which are at the present time entirely confined to the Australasian region.

(a.) Echidnidæ.—In this family only two genera are now recognised, of which Proechidna is confined to New Guinea. The other (Echidna) is common to Australia and Tasmania. It contains only one species, of which three varieties or geographical races are recognized by Mr. Oldfield Thomas.

The first of these, *E. aculeata var. lawesi*, is confined to New Guinea.

The second, *E. aculeata var. typica*, (the *E. hystrix* of most authors), is widely distributed over Australia, occurring in Queensland, New South Wales, Victoria and South and Western Australia.

The third, *E. aculeata var. setosa*, is confined to Tasmania and adjacent islands, passing northwards into King Island.

The Australian may be regarded as the typical form from which the New Guinea one appears to differ less than the Tasmanian.

In these forms we see a gradation in size, the New Guinea being the smallest and the Tasmanian the largest. In the former the spines are shorter than in the other two; in the Tasmanian variety the spines of the back are short and stout and exceeded in length by the hair, whilst in the typical variety the dorsal spines are long and hide the hair growing between them.

(b.) Ornithorhynchidæ.—In this family only one genus and species is recognized; viz., *Ornithorhynchus paradoxus*, the platypus. This is strictly confined to the Australian Continent and Tasmania, not passing northwards as does Echidna into New Guinea, or even into Northern Queensland.

(3.) Metatheria.—In this account I shall follow the classification adopted by Mr. Oldfield Thomas in his catalogue of Marsupialia and Monotremata of the British Museum collection (1888), and will deal separately with the two sub-orders into which the single order which it contains, the Marsupialia, is divided.

(a.) Diprotodontia.—This includes three families, the Macropodidæ, Phalangeridæ and Phascolomyidæ, all of which are represented in Tasmania. The three families include 25 genera and 89 species, of which Tasmania has 7 genera and 10 species. Victoria, on the other hand, has 14 genera and 22 species, or almost exactly double the number of each present in Tasmania. All the genera represented in Tasmania are common to South Victoria and of the 10 species 3 are peculiar to Tasmania, and the remaining 7 are common to Victoria; though of these 7 it is interesting to note that 4 are distinct varieties peculiar to Tasmania.

The most interesting forms are the following:—

In the genus Macropus, which includes the kangaroos and wallabies, three species are represented. The first of these is *Macropus giganteus var. fulginosus*, which replaces in Tas-

mania the typical form of the great kangaroo on the mainland. It is as large as, or larger than, the latter, with fur much longer, darker and coarser. The other two species of Macropus belong to the group of large and small wallabies respectively. The former is represented in Tasmania by one form, *M. rufficollis var. bennettii*, which is merely the climatic variety of the type species found on the continent in South Victoria and New South Wales. *M. billardieri* represents the smaller wallabies and is apparently identical with the form prevalent in S. and S. W. Victoria, and the south-eastern parts of South Australia.

The genus Petrogale, including the rock wallabies, is distributed over the whole of Australia, but does not occur in Tasmania; and the same is true of Lagorchestes, the hare-wallabies.

Bettongia has one species *(B. cuniculus)*, the Tasmanian jerboa kangaroo, common to South Victoria and Tasmania. In Mr. Oldfield Thomas' list this is stated to be a Tasmanian species only but in the Melbourne Museum there is a specimen from the Upper Yarra district. The genus Potorus *(Hypsiprymnus)* is represented in Tasmania by *P. tridactylus*, the common rat kangaroo. This form is widely distributed, occurring in Tasmania, Victoria, New South Wales and South Australia. There are considerable variations in size and in Tasmania there appear to be two forms, one larger than those of the mainland and another dwarf form described formerly as a distinct species *(P. rufus)*.

Dromicia is a small but interesting genus comprising the dormice-phalangers. Thomas gives two species as peculiar to Tasmania, *D. lepida* and *D. nana*, and the range of the genus as New Guinea, W. Australia and Tasmania. He says:—"This genus is evidently intermediate between Acrobates (pigmy flying phalanger) and Petaurus (the ordinary flying phalanger), and has apparently had to give way to these more highly specialized and, presumably, later forms, wherever the two have come in contact. Of this the distribution of the genus is a curious example, since it is isolated in the three regions must curious for their retention of ancient forms—New Guinea, W. Australia, and Tasmania—while no species appears to live now in the temperate parts of Eastern Australia, where the most highly-developed genera above referred to have their home, and where, judging by its present distribution, Dromicia must once have existed." It appears, however, that the second species *(D. nana)*

occurs in South Victoria, though not recorded from this locality in the British Museum Catalogue.

Pseudochirus, including the phalangers, is represented by one peculiar species (*P. cooki*) in Tasmania, whilst a second (*P. peregrinus*) occurs in South Victoria, S. Australia, New South Wales and Queensland. A third is confined to W. Australia, 3 to Queensland, and 4 to New Guinea. The 3 species, *P. peregrinus*, the common ring-tailed phalanger, *P. occidentalis*, the western ring-tailed phalanger, and *P. cooki*, the Tasmanian forms, are evidently closely allied, but, according to Thomas, the Western Australian is more closely allied to the Tasmanian than to the Eastern form, from which the one is separated by an impassable desert, the other by Bass Straits.

The common phalanger of the continent, *Trichosurus vulpecula*, is represented by a climatic variety (*var. fuliginosus*) in Tasmania, whose "size is markedly larger, and form stouter and heavier than in the typical variety. Fur longer and thicker." Phascolarctos has only one species, *P. cinereus*, the Koala, or native bear of the continent, distributed through Victoria, New South Wales and Queensland, but curiously absent from Tasmania.

The family Phascolomyidæ has but one genus (*Phascolomys*, the wombat) with 3 species, of which one, *P. mitchelli*, the common Australian wombat, is found in Victoria, New South Wales and S. Australia; a second, *P. latifrons*, the hairy-nosed wombat, is peculiar to S. Australia and a third, *P. ursinus*, is peculiar to Tasmania, but very similar to the Victorian form from which it differs chiefly in its smaller size, presenting thus, according to Thomas, "a remarkable exception to the usual rule of size in Tasmanian animals."

(*b*) *Polyprotodontia.*—This sub-order includes 3 families, of which 2, the Peramelidæ and Dasyuridæ are confined to the Australasian region, and one, the Didelphyidæ, to America. The two former contain 10 genera, of which 6 are represented in Tasmania, and 40 species, of which 9 are found in Tasmania.

There are 2 genera and 3 species peculiar to the island, which, it will be noted, is proportionately much richer in Polyprotodonts than in Diprotodonts. As in the case of the latter, so in the former, all the species, 6 in number, which it has in common with Victoria, are found in the southern division of that colony. There are 7 species in Victoria not found in Tasmania. Of these 4 are only found north of the

Divide and one in Western Victoria. All these are common to S. Australia. Two only of the 7 are found south of the Divide and of these, one (*Perameles nasuta*) is not found north of the Divide, passses up the East Coast into New South Wales, but is absent from S. Australia, and one (*Phascologale penicillata*) is found both north and south of the Divide and passes into South and West Australia, and northwards so far as Queensland.

Taking the Polyprotodont fauna of Tasmania and Victoria as a whole, we find that the former is allied to that of the southern division of the latter, whilst there is a distinct alliance between that of Victoria north of the Divide and that of S. Australia.

The forms of chief interest and importance are the following:—

The family Peramelidæ contains 3 genera of which 2 are not represented in Tasmania; one, Peragale, is confined to S. and W. Australia and the other, Chœropus, contains only one genus and species (*C. castanotus*), the pig-footed bandicoot, which is completely absent from the east and south-east costal region and hence from Tasmania. It ranges west of the Divide in New South Wales, north of the Divide in Victoria and then passes west into S. Australia and W. Australia. The genus Perameles, including the bandicoots, is represented in Tasmania by 2 species, one (*P. obesula*) widely distributed on the mainland, the other (*P. gunni*) confined to Tasmania and Victoria.

The family Dasyuridæ contains 3 of the most interesting of marsupial forms and, to quote the words of Oldfield Thomas, "as a whole presents one of the most generalized types found amongst the marsupials, its members being simply predaceous animals in no way markedly specialized and retaining, especially in the case of Myrmecobius, many of the characteristics of the earliest known marsupials." The genus Thylacinus has only one species (*T. cynocephalus*), the "Tasmanian wolf," of which, however, fossil remains have been found in New South Wales and Victoria.

Sarcophilus, again, has one species (*S. ursinus*), the "Tasmanian Devil," now confined to the island, though its fossil remains, like those of the Thylacine, are found on the mainland. The genus Dasyurus, including the destructive dasyures or "native cats," is widely distributed throughout the continent and has 2 species represented in Tasmania, of which both are common to Victoria. Here, again, we have

to notice that one form (*D. viverrinus*), the "native cat," is found both north and south of the Divide, and spreads westwards into S. Australia and northwards into New South Wales, whilst the other (*D. maculatus*), the "tiger cat," is found only south of the Divide and in the north-east part of Victoria, ranging up the East Coast from Tasmania to Queensland but not passing to the westwards to S. Australia or W. Australia. Further, at the present time this species is comparatively rare on the continent and much commoner in Tasmania. A third form, *D. geoffroyi*, is found in Victoria, but only north of the Divide and hence, as might have been expected, not in Tasmania. It ranges westwards to W. Australia and northwards to Queensland, being found in New South Wales on the west of the Divide and not in the coastal district.

In the genus Phascologale (Antechinus) Tasmania has two representatives, one confined to it and south-east Victoria (*P. swainsonii*), the other a peculiar species whose northern limits are the islands of Bass Straits (*P. minima*).

Comparing the Diprotodontia and Polyprotodontia of Tasmania, we have to notice the following points:—

(1.) The greater proportional number both of genera and species of the second as compared with the first group present in the island.

(2.) The presence of two peculiar genera of the second.

(3.) The absence of polyprotodont forms which are evidently climatic varieties of mainland forms and of which four are present amongst the diprotodonts.

The third of these seems to point to the conclusion that the polyprotodonts are not so capable of variation as the diprotodonts and under new conditions of environment, organic or physical, either persist unchanged or else entirely succumb.

Undoubtedly the one most striking feature in the fauna of Tasmania is the presence of Thylacinus and Sarcophilus and their absence at the present time from the mainland, whilst an almost equally noticeable feature, and one intimately associated with the former, is the presence of the dingo (*Canis dingo*) on the continent and its absence from Tasmania.

Mr. Krefft, in his paper on the Zoology of Tasmania, mentions the dingo as being extinct, but, as pointed out by Mr. Morton Allport, he had not the slightest justification for this statement, there never having been produced, as yet, any evidence of its existence south of Bass Straits.

Several writers, as Messrs. Oldfield Thomas, Allport, and Lucas, have naturally suggested the presence of the dingo as intimately associated with the extinction of the Thylacine and Sarcophilus and there can be little doubt but that this is perfectly correct.

It is, perhaps, worth while looking a little more closely into this question than has yet been done. Unfortunately, we are quite in the dark on what is, perhaps, the most important point of all, namely, the time of the earliest appearance of the dingo in Australia, or of the way in which it reached the continent.

Sir Frederick M'Coy has recorded the discovery of its fossil remains in what he terms the Pliocene deposits of Colac in company with those of extinct marsupial forms such as Thylacoleo, Diprotodon and Nototherium. In other deposits are found remains of the same marsupial forms together with those of Thylacinus and Sarcophilus so that there can be no doubt but that the dingo existed side by side with numbers of now extinct marsupial forms.

Now, amongst predaceous marsupials there are 3 important forms,—(1) Thylacinus, (2) Sarcophilus, (3) the Dasyures. The only predaceous Eutherian is the Dingo. At the present time the only predaceous mammals on the mainland are the dingo and the dasyures, whilst in Tasmania exist the Dasyures, Thylacinus and Sarcophilus, but not the Dingo.

If we look at the habits of these various forms we notice that the Thylacine, Sarcophilus and Dingo are fossorial or, at all events, ground animals, subsisting on prey which they can capture on the ground and hence coming into keen competition with each other whilst the Dasyures are arboreal in habit and hence can prey on animals inaccessible to the other three. Further, whilst the Dingo hunts often in packs, the Thylacine and Sarophilus are essentially solitary animals, a pair, perhaps, making their home in a hollow log.

Thus the Thylacine and Sarcophilus have on the mainland come into much closer competition with the Dingo than has the Dasyure and as is usual when one animal meets another with the same habits and needs but more highly developed than itself the lower has given place to the higher.

The result of the struggle for existence has been exactly what might have been expected. Where the four predaceous

forms have come into competition the Dingo has driven out its two immediate competitors which can only now exist where it is absent; whilst there are clear signs that the remaining form which does not so directly come into competition with it is now being reduced in numbers and may ultimately have to give way.

General conclusions with regard to the Origin of the Monotreme and Marsupial Fauna of Australia and Tasmania.

The great classical work of Wallace, it is scarcely necessary to say, marked an epoch in our knowledge and understanding of the origin and relationships of the Australasian fauna and flora. Subsequent workers can follow in his footsteps and as fresh knowledge is acquired can fill in details which verify, or may to a certain extent modify, his conclusions.

Thus, with regard to his generalisations concerning Australia, Professor Tate has pointed out, in his address to this Section at the opening meeting of the Association in Sydney, that Wallace was mistaken in his assumption that an old Tertiary sea extended in a wide gulf from north to south through central Australia. Mr. Wallace recognised that for some long period of time the south-western part of Australia, that is, practically, the Autochthonian region of Professor Tate, must have been isolated from the eastern or Euronotian region. That this has been the case, though not apparently quite in the way suggested by Wallace, Professor Tate himself points out, and to the latter we owe the important demonstration of the probable manner of isolation of the Autochthonian region. I may here express my indebtedness to the facts and suggestions contained in Professor Tate's important contribution to our knowledge of the distribution of living forms in Australia.

We will now deal with the main points of interest in the Tasmanian fauna in its relationship to other parts.

The most interesting of these is naturally concerned with the Prototherian and Metatherian mammals. Of late years our knowledge of the fossil remains of primitive mammals has been vastly increased and various points concerned with their ancestry and relationships have been elucidated by such workers as Cope, Marsh, Osborne, Baur, Lydekker, and Oldfield Thomas. One of the most important discoveries is, perhaps, that of the presence of teeth in the young form or platypus, first discovered by Poulton, whilst to Oldfield

Thomas we owe a fuller understanding of their nature and relationships.

We may, apart from the Eutheria, divide Australian mammals into three main groups,—(1) *Monotremata*, (2) *Polyprotodont marsupialia*, and (3) *Diprotodont marsupialia*.

In Europe, America and Africa we have evidence of the existence, either now or previously, of two groups,—(1) a series of forms, all fossil, grouped together as the *Multituberculata;* (2) *Polyprotodont marsupialia*,—all extinct except the single American family Didelphyidæ. That is, the Monotremata and Diprotodont marsupialia are confined to the Australian region, the Multituberculata are not found in it, whilst the Polyprotodont marsupialia are common to it and other regions.

The Multituberculata and Monotremata are by some authors placed together in the Prototheria mainly on account of a general resemblance between the tuberculate teeth of these forms and the Monotremes. The former possess a single pair of lower incisors as do the diprotodonts; but it is the second and not the first upper incisor which becomes enlarged and opposed to the incisor of the low jaw. The secant fourth premolar also differs in shape in the two and in face of these differences and the absence of knowledge as to other important parts of the skeleton, such as the pectoral girdle, all that can, perhaps, safely be said is, (1) they cannot be classed with the Diprotodontia and (2) they form a group not represented in Australia, but once widely spread over Europe, America, and Africa.

Both Multituberculata and Diprotodontia may be regarded as modifications of an original polyprotodont type, which, there can be little doubt, was much more primitive than either of the two former and closely resembled what we may consider as the ancestral form of all Metatheria.

The relation of this ancestral form to existing monotremes is a matter of conjecture; but the latter appear to retain characters common to themselves and to groups more primitive than the marsupials, or probably also than the immediate polyprotodont ancestors of the latter. Such characters are, for example, the structure of the pectoral girdle and the oviparous habit.

Professor Cope came to the conclusion that the extinct reptilian forms—the Anomodontia—were to be regarded as the ancestors of Mammalia. Subsequent research has shown a close relationship to exist between the Anomodontia and

the Labyrinthodontia, the latter being probably the ancestors of the former. Messrs Flower and Lydekker say: "We may probably regard the Mammalia as having originated from the same ancestral stock at the time the amphibian type was passing into the reptilian. From this point of view some of the mammalian features found in the more specialised Anomodonts may probably be regarded as having been acquired during a parallel line of development." Whilst much is mere conjecture, we may, I think, best explain the mammalian fauna of Australia by supposing a course of development and distribution somewhat as follows:—

Far back—certainly in Palæozoic times—there existed a group of forms of a generalised amphibian type. These we may for convenience term the ARCHITHERIA. From this ancestral Architherian stock we may imagine the development of different groups as taking place along lines perhaps at first more or less parallel and then divergent. On the one hand arose the amphibian stock and, along lines running at first more or less parallel to this, the primitive sauropsidan forms, whilst one main line of development led to the PROTOTHERIA.

In this group we may suppose that whilst certain features of the earlier forms were retained—such as, notably, the amphibian-like structure of the pectoral girdle and the oviparous habit—there were developed for the first time definite mammalian characters. Of this group the *Monotremata* are the only but much modified survivors. From the PROTOTHERIA arose a group of forms which we may call the ARCHI-POLYPROTODONTIA and which may be regarded as having possessed a generalised marsupial structure. The amphibian form of pectoral girdle had been modified, the oviparous habit lost and the viviparous gained, though as yet they were non-placental. From these generalised polyprotodont forms arose on the one hand the METATHERIA, and on the other the EUTHERIA.

It seems necessary to postulate the existence of some such group as this before the development of either Eutheria, Multituberculata or Diprotodont marsupials, as otherwise it would be difficult to explain the absence of the two first from Australia, or of the third from Europe, Africa and America.

We may now attempt to trace the course of events as they appear to have succeeded one another in Australia.

The first mammalia to reach the region which must of necessity have at one period been connected with South-east

Asia were the Prototheria. These entered in early Mesozoic or, at all events, pre-cretaceous times, and spread far and wide as is indicated by the wide distribution of their surviving forms.

Probably also they entered to the north-west rather than to the north-east side, or if on the latter they could not have touched—as Wallace long since pointed out—that portion which was continuous with the northern prolongation of the New Zealand sub-region and along which passed the ancestral struthious birds.

After a longer or shorter interval, in all probability immediately before the cretaceous period and under conditions which enabled them at first to spread with comparative ease over the greater part of the continent, entered the early polyprotodont forms. There is evidence, as will be shown soon, that these also entered towards the north-west rather than towards the north-east. Soon after their entrance the the northern land connection with Asia sank below the sea and though wave after wave of new and higher animal forms reached the southern Asian coast only stragglers crossed at rare intervals to the Island groups between the two continents and fewer still reached Australia.

At this early period there were thus on the Australian continent two mammalian groups—(1) the Prototheria and (2) the early polyprotodonts—the latter being the representatives of the Archi-polyprotodontia. There were no highly specialised marsupial forms and at most only the foreshadowings of the main groups. Competition would take place between the Prototherian and Metatherian types resulting in the preservation of only two much modified members of the former, the one protected from marsupial and other foes both by its armour of spines and its burrowing powers; the other by its amphibious and burrowing habits. Both at and previously to this time Tasmania must have formed a southern prolongation of the continent, and have been easy of access. Gradually the primitive polyprotodonts spread over the whole continent together with the Tasmanian region and gave rise to the various forms now and previously existing; the one which retained most nearly the primitive form being the Myrmecobius of West and South Australia. It appears, however, as though migration had taken place from the west in a southerly direction and then towards the east, and as if the Cretaceous sea had intervened during this period of migration and prevented ready access to the north-east.

Thus, whilst the struthious birds undoubtedly spread southwards from North-east Australia towards Tasmania, in all probability the polyprotodont marsupials came down from the north-west to the south-west then across to the east, being forced to travel further and further south by the encroaching Cretaceous sea. There was in Cretaceous times little or probably no hindrance to their spreading over the south-east part formed by what is now Victoria and Tasmania, but towards the north-east they could only pass along the comparatively narrow belt of high land which lay between the inland Cretaceous sea and the open ocean.

At some period during Tertiary times as indicated by the deposits in South Victoria, in North Tasmania and on the islands of Bass Straits, and comparatively early in this period, Tasmania began to be gradually separated off from the mainland. Previously, however, to this separation the genera and species of existing polyprotodonts had largely been developed. The Dividing Range was possibly higher then than it is now —at all events, we find, in addition to widely-spread forms, a set of species on the south and east not present on the north and west and another on the north and west not present on the south and east.

When Tasmania became separated off it contained a series of forms identical, so far as *genera* are concerned, with those of what is now Victoria and in *species* almost identical with those of South Victoria.

Very early in the Tertiary Period, or soon after the polyprotodonts had reached the future Euronotian Region, variations arose in certain of the forms and the earliest diprotodonts were gradually developed. There is, I think, clear evidence that these appeared first in the Euronotian Region—probably in its sub-tropical parts—and spread thence northwards, southwards and then westwards. Professor Tate has pointed out that at the close of the Cretaceous Period physiographical changes occurred resulting in the production at one time or another of barriers to migration towards the west. Central Australia, previously covered by the Cretaceous sea was now dry and possibly desert land offering a climatic barrier; to the south of this lacustrine beds indicate the existence in Pliocene times of a great lacustrine area centering round Lake Eyre and probably extending over what is now the Murray Desert and the Riverina; whilst further south again marine tertiary deposits indicate a considerable submergence of the south and south-eastern parts

of Australia—a submergence which, as before said, finally separated off Tasmania.

When once developed the diprotodont forms rapidly spread south along two paths, one to the east and then to the south of the Divide, another to the west and then to the north of the Divide. Though not of course perfectly distinct from one another, certain widely-spread forms occurring in each, still, speaking generally, we may say that the east and south (using these terms relatively to the Divide) gave rise to the coastal diprotodonts in New South Wales and Victoria, whilst the west and north forms spread westwards into S. and W. Australia, though their migration was considerably hindered by the barriers mentioned above.

It was most probably whilst Tasmania was gradually being separated off from the mainland, and when it retained a relatively small connection by a neck of high land passing across what is now the east of Bass Straits, that the migration of the diprotodont forms was taking place down the east coastal district. Hence it was that comparatively few crossed into Tasmania, a strikingly smaller proportion of diprotodont than of polyprotodont forms being present in the Island.

We must conclude from the mammalian fauna that there has been no absolute land connection between south-east Australia and Tasmania since practically the end of the Tertiary Period or early in Pleistocene times, as otherwise it would be impossible to account for the absence, not only of the dingo, but of the large and specialized diprotodont fauna of which the Pleistocene Period saw the rise and fall upon the mainland.

If tables of the comparative distribution of the genera and species of polyprotodont and diprotodont forms respectively be drawn up for the various parts of Australia, including Tasmania, we find in them, I think, evidence of the truth of the three main suggestions included in the above account. These are :—

(1.) That the primitive polyprotodont fauna entered by the north-west rather than by the north-east part of the continent, spread thence south and then across to the east.

(2.) That the diprotodonts had their origin in the Euronotian region and spread thence southwards and westwards.

(3.) That during the development of the polyprotodont fauna Tasmania formed part of the continent and was separated at all events before the full development of the diprotodont fauna.

The *Polyprotodontia* have altogether in the Australian region, including Tasmania, 10 genera and 40 species. If we take the percentage of these present in the different colonies, we find the result to be as follows:—

	Tasmania.	Victoria.	New South Wales.	South Australia.	Western Australia.	Queenslaud.	New Guinea and Islands.
Genera	60	50	60	70	70	40	30
Species	22	35	32	32	30	25	30

The *Diprotodontia* have altogether in the Australian region, including Tasmania, 25 genera and 89 species. If we take, as before, the percentage of those present in the different colonies we find the result to be as follows:—

	Tasmania.	Victoria.	New South Wales.	South Australia.	Western Australia.	Queensland.	New Guinea and Islands,
Genera	28	56	56	44	44	56	36
Species	11	25	31	20	18	34	22

The above tables show, first of all, that speaking generally the various portions of the Australian region contain a considerably greater proportional part of the polyprotodont than of the diprotodont fauna. Beyond this we note a very even distribution of genera over different parts of the region with the exception of the north-eastern, where the least percentage is present.

Supposing the forms to have entered from the north east then the connection with Asia must have taken place over

land of which New Guinea now forms part and yet New Guinea has the least, and Queensland the next least, percentage of forms present. On the other hand the greatest percentage of genera is possessed by South Australia and West Australia. Now there can be little doubt but that the struthious birds entered by the north east, and in the case of these we find that this portion is the richest both in genera and species.

The conclusion that can be apparently drawn from the comparative distribution of the Polyprotodonts is that they did not enter by way of the north east but that, on the contrary, this was the last part which they reached. Their comparatively very equal distribution over the whole continent and Tasmania, except this one part, and their strong development in South and West Australia seem to indicate that during the time of migration of these, which are undoubtedly, the more primitive of the two marsupial groups, there did not exist such distinct barriers of climate or geographical features as existed later on, though in all probability during their early distribution the Cretaceous sea was encroaching on the land. Further still, their strong relative development in Tasmania indicates that this then formed simply a southern projection of the mainland.

It might possibly be suggested that though the forms entered by the north east the small percentage of Queensland polyprotodonts is due to extinction following upon subsequent competition of the diprotodont forms. The answer to this is that Victoria and New South Wales have very nearly the same percentage of diprotodont forms (exactly the same in genera) and yet competition has not by any means affected their polyprotodont fauna in the same way.

If we now compare the tables giving the percentage of diprotodont forms present in the various parts we find a very different result. The order being Queensland, New South Wales, Victoria (all three of which are comparatively rich), then a considerable break and South and West Australia nearly equal, then another larger break still and Tasmania.

These results can, I think, only be interpreted to mean one thing and that is, that the Diprotodont fauna arose and reached its highest development in the subtropical regions of the Euronotian province, that is, in South Queensland and northern New South Wales. Thence it spread easily northwards through Queensland and so to New Guinea and the islands, then becoming separated off and southwards partly

along the east and partly along the west side of the dividing range. In the south-east part of the continent and in the central region barriers to migration were present. The first of these consisted of Bass Straits across which there could have been only a gradually disappearing and almost lost land connection with Tasmania. The second series consisted possibly in a desert region to the north of the central part and a great lacustrine region in the south, together with a submergence beneath the sea of much that is now dry land along the present coast line. These various barriers made communication with Tasmania and South and West Australia comparatively difficult, and hence it is that the former is so remarkably poor in diprotodonts whilst the two latter are also relatively poor though their isolation has not been so complete as that of Tasmania.

Relationship to New Zealand.—There remains to be considered finally the relationship between Australia and New Zealand. This subject is one of extreme difficulty and has been dealt with by Wallace in his "Island Life," and by Hutton in his papers on "The Origin of the Fauna and Flora of New Zealand," in the *Annals and Magazine of Natural History* for 1884 and 1885. Both of these authors agree in supposing that an intermittent connection has existed at some time by means of a greater extension of land in Antarctic regions than is now found. Beyond this Wallace accounts for the facts of distribution, as presented to us, by means of an ancient land connection between New Zealand and the north-eastern part of the old Australian continent, and Hutton by means of the former existence of a South Pacific continent, with which was connected a large land mass extending from East Australia to India, and with New Zealand as a southern offshoot. Further, Professor Hutton states that the South Pacific continent must have existed after the Jurassic and have been submerged before the Eocene period.

We may, to begin with, divide all those forms revealing affinity between the faunas of Australia and New Zealand into three main groups. (1) Those forms found widely distributed in Australia and occurring also in New Zealand. (2) Those which are found in the south east of Australia, including Tasmania (or more strongly developed here than in the north east) and in New Zealand. (3) Those which are found in the north east of Australia and not in the south east (or most strongly developed in the former) and in New

Zealand. With regard to the first and second of these groups there is comparatively little difficulty.

Of the first group we may instance Peripatus and the genus Lycæna amongst the Lepidoptera. Peripatus has been found along all the eastern coast of Australia from Mount Bellenden Ker in the north to Tasmania in the south, and further search will doubtless reveal its existence in suitable parts elsewhere in Australia. It can evidently thrive under very varying conditions of climate. Its existence elsewhere in South Africa, South America and New Zealand shows that existing ones are relics of a widely-dispersed form, and its area of distribution tells neither for nor against Wallace's or Hutton's theory.

So again with Lycæna, which is widely distributed over the Palæarctic and Nearctic regions, N. India, Australia, New Zealand, S. Africa and Chili.

Of the second group the fresh water fishes form the notable example. Of these the genera Galaxias, Retropinna, Anguillula, and Prototroctes reveal affinity between Southern Australia and New Zealand, and the further affinity of both these parts with S. America may be satisfactorily accounted for by intermittent land connection across the Antarctic region. At the same time it is worth noting that no such community of forms exists between S. Africa and the southern parts of Australasia and America.

It is the manner of distribution of the third group which is very difficult of explanation. Here we have forms which are found in north east, and not (or only slightly) in south-east Australia and in New Zealand, and at the same time are allied to S. American forms.

Moreover, as pointed out by Hutton, they have another characteristic feature in their distribution, and that is their absence from Africa.

Their absence from south-east Australia and Tasmania and strong development in the north east may be regarded as proof that their distribution has not taken place as with fishes (except possibly in one instance, that of Acanthodrilus amongst the Vermes), and we have the two theories of Wallace and Hutton to choose between.

Included in this third group we have examples of worms, amphibia, land mollusca, and insecta. In the worms we have the genus Acanthodrilus characteristic of New Zealand, with species in Patagonia, Falkland Islands, South Georgia, Kerguelen Island, the Marion Islands, S. Africa, and two

in Northern Australia. There would certainly be little difficulty in regarding the present as the relic of a once more universal distribution and as due to migration from some northern centre. At the same time it is quite possible that, as Beddard suggests, Acanthodrilus may be a New Zealand genus and its representatives in other southern parts be due to migration southwards (though not by means of a continuous Antarctic continent), whilst the North Australian species are the result of a small northern migration. At all events a southern Pacific continent would not help much in explaining the curious distribution of this typical New Zealand genus.

Tempting though it may be to accept Professor Hutton's theory it appears to me as if we were scarcely justified in doing so. It has rather the appearance of calling in the aid of a large cause to explain a relatively small result.

The differences between S. America and Australasia very far outweigh any resemblances, remarkable though some of these are, in amphibia, land mollusca, and insecta, whilst in reptiles, birds, and mammals, there is no affinity worth mentioning when compared with the striking contrasts between the two regions, and such affinity as there is may be explained quite otherwise.

The lack of affinity with S. Africa is not conclusive evidence against a southern migration from northern sources and may be due to two causes, either the extinction of forms, as in the case of early metatheria (or form closely allied to these), or the isolation of Africa during the migration of forms from a Eurasian continent.

It may be pointed out that we know of certain allied forms in Australasia and S. America where the distribution is most evidently a remnant of an ancient, much wider one, as in the case of the Dipnoi. Though their distribution is as remarkable as that of any insect or molluscan form indicating alliance between S. America and Australasia still there is no need to explain it by means of a S. Pacific continent.

If, again, New Zealand were closely connected with the latter it would be somewhat difficult to explain its extreme poverty in such insects as the Buprestidæ in which Eastern Australia shows a marked affinity with S. America. At the same time the distribution of this family is very difficult indeed to account for owing to the affinities of the Australian region with the Neotropical and Oriental on the one hand and the marked distinction between the Neotropical and

Nearctic on the other. Wallace's idea of a southern migration from the temperate regions of Australia seems to be negatived by the fact that the parts into which they must have passed, viz., New Zealand and South-Eastern Australia with Tasmania are very poor, especially the former, in representatives of the family. It is, of course, possible that they may have undergone gradual extinction in these parts.

Professor Hutton, as before said, dates the S. Pacific continent as not earlier than the Jurassic nor later than the Eocene period. If, allowing of course considerable limits of time, there existed anywhere within or about this period a direct land connection between S. America, New Zealand and Australia the difficulty would appear to be not to explain the amount of affinity which does exist but the lack of much greater affinity which does not exist.

At the present time, whilst fully acknowledging the difficulties and granting that there may once have been a considerably larger land surface in the Pacific than now exists, it seems safer to conclude that there has not existed a *direct* land connection between S. America and the Australasian region, and that the affinities between these two regions have been brought about mainly by migrations southwards across the Eurasian continent in the Old World and the American in the New and partly, though to a much less extent, by migrations across Antarctic lands.

Section E.

GEOGRAPHY.

Address by the President,

CAPTAIN PASCO, R.N.

It is with unfeigned diffidence that I venture to accept the position which such a distinguished member as Sir William Macgregor has (I am, as no doubt we are all, sorry to say) been unable to occupy *in propria persona.* Sir William, who first came prominently into notice by an act of consummate bravery some years since during a hurricane at Fiji, when, at the risk of his life he nobly earned a decoration which, in my humble estimation, is more to be coveted than the Victoria Cross—viz., the Albert Medal—has latterly been intrusted with the latest annexation of British Territory in the Southern Hemisphere. Sir William's governing policy, we are proud to say, follows closely in the lines of Sir Stamford Raffles and Rajah Brooke among the tribes of the Indian Archipelago, which are so nearly allied to the Papuans, in recognizing aboriginal claims and framing laws for their protection.

In addition to his noble character as a philanthropist, he has specially commended himself to the Geographical Section of this Association by his recent explorations in New Guinea, where he has distinguished himself by his ascent of the Owen Stanley Range.

Allow me, then, at the outset to place on record the regret of this Section that we are denied the presence of a more worthy President.

Instead of following the usual lines of Presidential addresses by recapitulating geographical researches in various parts of the world up to date, I desire, at the first meeting of the Australasian Association for the Advancement of Science in Tasmania, briefly to recur to what may be considered as the origin of geographical research, and how we, at the close of this nineteenth century, are responsible for the exercise of our energies.

No one present, I trust, will object to a reference to the imperishable Volume in which is recorded the creation, not only of this speck we call the earth, but of the entire universe.

Finite man in his ignorance thought to centralize his race in such a way as to avoid being "scattered abroad on the face of the whole earth," (Gen. xi., 4), and thus he would have failed to fulfil the command given in Gen. i., 28, to "subdue the earth and have dominion over the fish of the sea." But the beneficent Creator—the Infinite One—who knows the end from the beginning, mercifully frustrated that exercise of folly by confounding language and "scattering them abroad on the face of the whole earth." This was the Alpha of Geographical Science. For the families of mankind being divided, their pursuits and interests were no longer identical: thus circumstances not of their own creation led them to regard the commodities of their neighbours as necessaries to be acquired; and this, in due course, would give birth to commercial enterprise.

In the infancy of the human race men were ignorant of their own planet being a sphere, but regarded it as a flat disc,—as I have heard aborigines in Australia explain their ideas in that respect when I have endeavoured to show them that the earth is round and turns on its axis, which makes the other heavenly bodies appear to rise and set. The primitive child of the soil replied, "that only white-fellow fashion, but not that way along a black-fellow." He further thought the sun very cunning, as he would deceitfully creep along the sky all day very slowly, but directly he sank below the horizon he hastened along all night, while we sleep, to be ready in the morning to resume his former slow pace.

But to subdue the earth and have dominion over the fish demanded the cultivation of the science of navigation, which was essential to the extension of geographical knowledge; and though for a considerable period the knowledge of the habitable globe was limited to the countries lying around the Mediterranean, in due time, either from curiosity or cupidity, seamen boldly faced the Atlantic, and, following the coast line northerly, viewed what they appropriately named the "Land's End," or Cape Finisterre. The name of that Cape possesses a historical interest which is rarely conveyed by teachers of geography.

The early Egyptians, soon after that country became a monarchy, Robertson the historian tells us, carried on a trade between the Arabian Gulf or Red Sea and the

western coast of the Indian Continent. The Phœnicians proved themselves more enterprising in commercial pursuits, and extended their travels further, bringing to the Mediterranean peoples a knowledge of the valuable commodities of the East. Thus a desire to excel in nautical skill was promoted, that the treasures of Cathay might be reached by water instead of by the more tedious land travel.

Maritime discovery, thus inaugurated, reached its zenith in the epoch of Columbus, who may be regarded as the discoverer, for practical purposes, of the Western Continent; for though the hardy Norseman had long before crossed to Iceland and thence to the American mainland, he had not widely published the fact to the world. To this period also belong Fernando Magalhaens, or Magellan as he is commonly called, who followed down the east coast of South America to reach India on the westerly track, and Vasco da Gama who rounded Africa to the eastward with the same object.

Thus little by little, "here a little, and there a little," islands and continents are added to the map of the world; while intrepid and determined spirits like Marco Polo undertake perilous and fatiguing land journeys, opening up a friendly intercourse with Asiatic tribes, and making acquaintance with those varied scenes of nature, to which Alexander von Humboldt thus refers in his Cosmos :—

"It may seem," he says, "a rash attempt to endeavour to analyse into its separate elements the enchantment which the great scenes of nature exert over our minds. The richest and most diversified materials for such an analysis present themselves to the traveller in the landscape of Southern Asia and in the great Indian Archipelago." Again, on the tropical Andes, the mighty Cordillera of South America, Humboldt reminds us that man is permitted to contemplate all the families of plants, and all the stars of the firmament, at a single glance ; to see the lofty feathered palms, forests of bamboo, and, above these tropical forms, oaks and umbelliferous plants, as in our European homes; there, too, both the celestial hemispheres are open to his view, and he may see displayed together the constellations of the Southern Cross and the Great Bear, each circling round its respective Pole.

Whether in the torrid or the frigid zone the traveller is charmed with varied nature and encouraged to advance toward the completion of the survey. Such often has been the experience of explorers in Australia, where but half

a century ago portions of its north-west coast were indicated by a dotted line with the remark, "No land seen in this direction." The filling up of such portions was often attended with some measure of excitement, the explorer not knowing when passing one cape what he would meet with beyond; while an indentation betwixt capes might prove the *embouchure* of a large river, as was the case when the Victoria River was discovered in the Cambridge Gulf by Captain Wickham, in the *Beagle*, in November, 1839. In such voyages of discovery intercourse with the aborigines has often been an occasion of considerable interest; they, possessed with the timidity of children, being easily won by a little tact, and frequently reciprocating kindness shown to them. Indeed, the influence of such men as Sir Stamford Raffles and Rajah Brooke, to whom I before alluded, is most valuable to those who follow them, though, unfortunately, the good effect of the conduct of such as these is too often subsequently destroyed by an opposite course of action, when the race is likely to be maligned by their character being reported as treacherous. I might here remark on the benefit conferred on explorers by the good influence of missionaries, when they have been the pioneers; the noble Moravian brethren, who have devoted themselves to winning the friendship of tribes in every zone from the Arctic to the Torrid, have been conspicuously in the front rank.

In this beautiful island in which we are now assembled, the science of Geography was most worthily represented just fifty years ago in the person of the late Sir John Franklin, who may be recognised as the founder of the Royal Society of Tasmania, and who, in 1842, while filling the high office of Her Majesty's Representative, undertook an explorative expedition to cross the island from New Norfolk to Macquarie Harbour, the district which mining enterprise is now so rapidly developing.

Without recapitulating geographical researches in the continents of Asia and Africa, I may be excused for confining my attention to the progress of geography near home in this southern hemisphere. Central Australia half a century ago was considered to be a vast desert and howling wilderness, with possibly a great inland sea; for an idea once existed that the rivers which empty into the Gulf of Carpentaria drained such an expanse. But Stuart, M'Dowell, Gregory, Forrest, Giles, and others, have dissipated that dream by crossing the continent in various lines, leaving a respectable

balance of exploration for Mr. Lindsay of to-day, under the munificent auspices of that true patriot Sir Thomas Elder, G.C.M.G., of South Australia, to complete. I will not detain you with further remarks upon this subject, as I understand that our Section is to be favoured with an account of Mr. Lindsay's work from one who is far better acquainted than myself with what has been, and is being done.

But the subject of Geography is not limited to *terra firma*—the ocean, likewise, has an important claim on the attention of true geographers. In like manner to the arterial and venous systems in the human frame, the ocean possesses a pulse, of great importance to the navigator, under the technical title of "Tides and Currents."

Lieut. M. F. Maury, LL.D., of the United States navy, has done much to enlighten us on this subject in his "Physical Geography of the Sea," and by encouraging navigators to carefully note in their logs the currents they detect during their voyages; but need of more systematic observations on these subjects becomes daily more pressing now that increased marine traffic multiplies shipping disasters on our coasts, when it is frequently endeavoured to cover the responsibility by reference either to an unexpected current or to an uncharted rock, though it may be the ship that was the uncharted thing. What appears to be a necessary course for meeting this need is to provide an universal system of tide and current register on all coast and island stations throughout the world; observations made in connection with meteorology to include the temperature as well as saltness of the sea water, the direction and force of the currents, and times of high and low water. Tidal observations have been established with much care in connection with the survey of India, and suggested by Professor G. H. Darwin. Since the commencement of the present century tidal observations have been carried out in India in order to furnish data for the trigonometrical survey, but it was not until 1855 that a self-registering tide-gauge was employed. Subsequently, it was desired to investigate the relations between the levels of land and sea on the coasts of the Gulf of Cutch, which were believed by geologists to be gradually changing. The example set by India in this direction, in the labours prosecuted by Major A. W. Baird, R.E., F.R.S., &c., under the direction of the Surveyor-General of India, we may hope will be followed by all civilised nations; and, with a view to commending this subject to the Tidal Committee of the British Association, may the Australasian Association venture

to suggest the establishment of a "term day," as was our practice at the Ross Bank Magnetical Observatory, Hobart, in the early days of the forties, when the oscillations of the magnetometers were simultaneously recorded in the various magnetic observatories throughout the world in both hemispheres. The data thus derived were of vast importance, and, doubtless, corresponding efforts directed to a more perfect knowledge of the tidal system may furnish a reliable clue to our climatic conditions in this latitude, which, there can be little question, are in a measure governed by the state of the Antarctic ice and currents therefrom.

Nearly sixty years ago Captain Walker, R.N., then Queen's Harbour Master at Plymouth, suggested respecting the tides that "the mean level of the ocean fluctuates with the mercury in the barometer in the proportion of sixteen inches rise and fall of the mean plane to one inch in the mercurial column," implying a sympathy between the oceanic and atmospheric tides, though there are many who deny that the attractive power of the moon, which it is universally admitted acts on the ocean, has any effect on the atmosphere.

Having already alluded to the efforts of Sir Thos. Elder to secure a reliable report from Mr. Lindsay of the state and condition of the hitherto untrodden portions of Central Australia, where room may be found for the congested populations of Europe and possibly of Asia, including the too much despised Celestial,—I may, in conclusion, briefly refer to another matter of exploration which just now occupies our attention. There is still a considerable area of this globe to be "subdued" and brought under the peaceable dominion of man, within the Antarctic Circle. Though Sir James Ross unfurled the British banner on an island contiguous to the Antarctic continent or archipelago, as the case may be, yet almost a blank on the map awaits the endeavours of the Anglo-Saxons located in the Southern Hemisphere to emulate their forefathers in the north by subduing the land lying around the Antarctic pole, and completing a work nobly commenced by James Cook and followed by Weddell, Biscoe, Ross, and Nares, with the vastly improved appliances of which this end of the nineteenth century makes its boast. Thus, by the aid of our Scandinavian cousins, we may hope soon to improve the assets of our several Chambers of Commerce by the addition of Antarctic sealskins and whalebone, now that the Behring Sea is temporarily closed to the sealer.

Section F.

ECONOMIC AND SOCIAL SCIENCE AND STATISTICS.

Address by the President,

R. TEECE, F.I.A.

A NEW THEORY OF THE RELATIONS OF WAGES AND PROFIT.

My first duty in addressing you is to acknowledge my obligations to the Council for the honour it has conferred upon me by electing me to the position of President of this Section. I cannot hope to fill the position with the same credit to myself or with such advantage to the Association as my predecessors in the office have done, but I have endeavoured, in the few fugitive hours which I have been able to snatch from the demands of a busy life, to put together a few thoughts, which more matured judgments than my own may be able so to develope as to make them in some small measure a welcome contribution towards the elucidation of one of the greatest economic problems of the age.

I propose to submit to you for your indulgent consideration what I conceive to be a new theory regarding the relations of Wages and Profit; but before I enunciate this theory I must ask you to bear with me while I make a brief historical retrospect of the past and a passing glance at the present position of that great economic problem which has come to be known as the conflict between Labour and Capital.

The most casual observer cannot have failed to notice that for many years past there has been a growing discontent on the part of that great section of humanity which, for purposes of distinction, we call the "labouring classes," with the conditions of life in which they find themselves placed. It is no part of my purpose now to discuss the question whether these conditions are more favourable now than they were 50 or 100 years ago: both sides of this question have had able advocates. All that concerns me is that this feeling of discontent is a real factor in our national life, and my purpose is to attempt to discover its cause and to suggest its cure.

All over the civilised world, but especially in English-speaking countries, men find themselves surrounded by conditions—placed in an environment—which they instinctively feel to be wrong, to be out of harmony with the boasted advancement of our civilisation. They ask for the cause of these conditions; they cry for relief from them and they can find no one to answer them, or, at least, they receive no answer which satisfies them. Laving the shores of our social, industrial, and national life is a wave of unrest, of disquietude, of anxiety, occasionally ebbing, but ever again flowing with redoubled turbulence, which cannot be dammed back by any frail barriers of expediency, and which can be rendered innocuous only by a diversion into channels which it is the duty of the political economist to dig. The position has been surveyed over and over again, but there is no agreement as to the direction of the channel, and in the multitude of counsellors those who are looking for relief find but little wisdom. Concurrently with this feeling of unrest, if not, indeed, the precursor of it, there has spread over the civilised world a wave of depression, and earnest men of all shades of thought have striven to explain the phenomenon. Mr. Henry George tells us that it is due to the private ownership of land; others affirm that the supply of gold has fallen short of the demand, and that the remedy is to be found in a bi-metallic currency; a third school will have it that free trade is largely responsible for the evil, and that the cure is to be effected by putting the manacles upon commerce.

Let us then endeavour to discover, first, what has caused this conflict between labour and capital; next, what efforts have been made to settle it; and, lastly, why have they failed? The arguments of both sides to the discussion are of a recriminatory character. The labourer asserts that the capitalist demands too much profit; the capitalist retorts that the labourer demands too high wages. Let us clear the ground by defining what is meant by the terms profit and wages. I do not propose at this stage to give my own definition, and it would neither assist me in my purpose nor suit your convenience if I were to repeat all the definitions of these terms which political economists have given. I shall sufficiently illustrate the most opposite doctrines on the subject by quoting Ricardo and J. S. Mill on the one hand, and the apostle of the Single Tax, Henry George, on the other. Before Adam Smith gave a new direction and impetus to the study of political economy the

prevailing doctrine was that in any transaction such as a sale there could be a profit to only one party to the bargain. Adam Smith dispelled this illusion, and in the present day the theory is held to be true only in selling horses and floating mining companies.

In his treatment of the question Ricardo invariably regards wages and profit as two antagonistic forces continually in opposition, any circumstances favourable to the one being necessarily prejudicial to the other. "Can any point," he says, "be more clearly established than that profits must fall with a rise of wages." And again, "The necessity which the labourer would be under of paying an increased price for such necessaries would oblige him to demand more wages, and whatever increases wages necessarily decreases profits." Mr. Mill elaborates the theory of a wages fund. He defines wages as "the remuneration of labour," and profits as "the remuneration of abstinence." The capitalist, he says, is the person "who from funds in his possession pays the wages of the labourers or supports them during the work." "The cause of profit," he says, "is that labour produces more than is required for its support." He concludes his exhaustive treatment of the question in these words:—"We thus arrive at the conclusion of Ricardo and others, that the rate of profits depends on wages, rising as wages fall and falling as wages rise." In view of these quotations it is somewhat difficult to understand Ricardo's latest editor, Mr. E. C. K. Gonner, when he says, speaking of Ricardo, "Just notice that he never asserts or imagines that wages and profits cannot increase together;" and then immediately proceeds to say, "Again, the two agents in production, labour and capital, so divide total value between them that an increase in the value obtained by the one implies a diminution in the share of value falling to the other." The position taken up by Ricardo and Mill is that wages and profits are two variables, that the one varies inversely as the other, and that when combined they constitute an invariable quantity. The truth of this doctrine seems to me further to depend on the assumption that the circumstances attending production are also invariable, but we know such an assumption to be untrue. The rapid increase in the facilities for transit, the extraordinary development occasioned by the introduction of machinery, the revolution wrought by improved processes, have all influenced the rates both of wages and profits. The extent and direction in which such influences have affected wages

and profits depend upon circumstances. It is not within my purpose to discuss these now; it is sufficient that I should indicate them.

There is another point which is not always kept in view, but which will be seen to be of considerable importance when I come to deal with Mr. Henry George, and that is the relative importance of capital and labour in the production of wealth. Accepting the usual definition that the sources of wealth are land, labour, and capital, we shall readily see that while the first is invariable, the two latter vary sometimes directly, sometimes inversely. In the manufacturing centres of old and densely-peopled countries like Great Britain labour is undoubtedly the great instrument of production, but in the case of these colonies, with their enormous areas of available land and their meagre populations, the converse is frequently seen to be true. Take, as an example, one of our great pastoral properties, where luxuriant grass and never-failing water are supplied by nature and the stock is supplied by capital. In such a case enormous wealth is sometimes produced with a minimum of labour,—a few boundary riders, with the addition of shearers and carriers in season, are all that are needed. In such a case there is practically no occasion for a wages fund: the wealth is produced by land and capital, and the profit surely belongs to capital. A rise or fall of wages, even of a marked character, would have practically little effect on the profits produced. The old economists appear to have ignored or to have attached slight importance to this possible variation of circumstances, and, consequently, to have argued from premises which were not universally true.

The Ricardian theory of the relation of wages and profit has more or less affected the views and influenced the conclusions of all the political economists who have succeeded him. It is not difficult to understand how the acceptance of this theory has created discontent in the breasts of those especially who have been compelled to earn their bread by the sweat of their brows. The great masses of the labouring classes, seeing, as they believed, the rich growing richer day by day; feeling, as they instinctively felt, their hard lot was not of their own creation; taught by political economists that what was being added to the wealth of the already wealthy was being abstracted from the fund available for their support, could not fail to become possessed by the conviction that employers and employed were engaged in mortal

combat, the issue of which would leave no quarter to the vanquished. I shall treat directly of the methods which were adopted in the conduct of this industrial warfare. But before I do so, it is necessary that I should refer for a moment to the view entertained by Mr. Henry George regarding the relations of labour and capital. Whatever opinions may be held concerning some of the theories of this distinguished economist, there can be little doubt, I think, in the minds of those who have been charmed by the elegance of his diction, or who have enjoyed the pleasure of personal converse with him, that he is a man of striking originality and of transparent honesty of purpose. He has given the world a valuable contribution to the discussion of this much vexed wages question; and if he has stopped short of the discovery of truth, I am bound to confess that it is to a comparison of his views with those of Ricardo that I am indebted for the theory that I shall venture to offer to you.

Henry George sets out by asking, "Why, in spite of increase in productive power, do wages tend to a minimum which will give but a bare living?" And he says, "The answer of the current political economy is that wages are fixed by the ratio between the number of labourers and the amount of capital devoted to the employment of labour, and constantly tend to the lowest amount on which labourers will consent to live and reproduce; because the increase in the number of labourers tends naturally to follow and overtake any increase in capital." He then states the proposition which is the cardinal point of his theory, viz., "That wages, instead of being drawn from capital, are in reality drawn from the product of the labour for which they are paid." To illustrate this theory he says, "For in all those cases in which the labourer is his own employer, and takes directly the produce of his labour as its reward, it is plain enough that wages are not drawn from capital, but result directly as the product of the labour." It must be remembered that George includes in the term "wages" all reward for exertion. Again, he says, "As the employer generally makes a profit, the payment of wages is, so far as he is concerned, but the return to the labourer of a portion of the capital his labour has previously produced." Once more he affirms, "Capital does not supply or advance wages, as is erroneously taught. Wages are that part of the produce of his labour obtained by the labourer." Now, it will be seen, that while George's theory is the direct opposite of that advanced by the old

economists, it does not remove the evils to which the old theory gave birth. Under the wages-fund theory the labourer came to the conclusion that the employer was getting more than his share of the fund. Under George's definition the labourer is taught, and is beginning to believe, that he is entitled to the whole, and that the employer or capitalist is an encumbrance on the industrial organisation. To those, therefore, who are seeking for some means by which the alleged conflicting interests of employers and employed can be harmonised—who feel that the interminable strife between capital and labour, which has become so intensified in these days, has resulted in a waste of the national energies—the Scylla of George is as much to be avoided as the Charybdis of Ricardo. Of course, no amount of definition can alter the relative rights or claims of labour and capital; but, as the attitudes of employers and employed are largely determined by their conceptions of these rights and claims, it is clear that a satisfactory solution of our difficulties can only be obtained by a true conception of the economic relations of wages and profit. Before indicating these, however, let us glance for a few minutes at the actions taken by both sides in the contest to secure a recognition of what they have held to be their just claims. We shall consider these under two headings:—

1. Strikes, lock-outs, and trade unions.
2. Co-operation.

To an unreflecting employer, the method which at once suggested itself as the infallible cure for disaffection or discontent on the part of his workmen was a lock-out, which speedily starved the recalcitrants into submission. To the equally unreflecting workmen the sure way to coerce an employer was to strike. To a successful strike, however, an organisation was necessary, and this was found in the trade unions. I do not propose to enter into a history of these organisations, but it is necessary that I should very briefly indicate their growth and development. In the early development of the industrial life of England we find the merchant guilds established for the common benefit of employers and employed, to regulate the conditions of the calling in which they were engaged, to secure the right of free discussion and association, and to safeguard their interests against the attacks of the patrician classes. In these guilds we find nothing to indicate any conflict of interest between employers and employed. On the contrary, it was presumably felt that

these guilds constituted a combination between employers and employed which was opposed to the public good, for we find that they were suppressed by law about the time of Henry VIII. Following this, we have the inevitable reaction indicated by the laws of Elizabeth and her successors. These laws were of the most oppressive, obnoxious, and meddlesome character, and the condition of affairs engendered by them ought to be sufficient to show the utter futility of State interference with the conduct of the industrial life of the nation. Mr. G. Howell, referring to the tendency now being manifested towards a return to this State interference, says, "If a cure for this frenzy be possible, probably the best cure will be a careful perusal of the legislation prior to the commencement of the present century, and a careful study of its effects. It nearly killed our early trade and nearly starved our people. It needs no prophet to foretell that the same results would follow if such laws were re-enacted." In the years 1824 and 1825 these laws which, for nearly two centuries, had fettered the commerce and trade of England were repealed, and from that period we may date the growth of those organisations which we now know as trade unions, which have played so important a part in the industrial progress of the race, and which are now in the acute stage of their development. The early attempts of the unionists at organisation, were, however, of a very imperfect character. Their energies were usually directed to the advocacy of strikes of a virulent and meaningless nature, entailing much suffering and loss, and failing to effect any useful purpose. In 1850 the establishment of the Amalgamated Society of Engineers inaugurated a new *régime*, and set an example which has been more or less closely imitated by succeeding unions. These unions were equipped for effective service by the accumulation of funds, and the institution of schemes of provident and other benefits. The passing of the Trade Union Act in 1871 gave the unions a legal status. It must not be lost sight of, however, that the trade unions of which we are now speaking are organisations of a very different character from those which within the last few years have sprung into being in England and these Colonies. The establishment of the unions of 1825 and 1850 was a protest against the improper interference of the State with the right of workers to dispose of their labour as they thought fit. They did not require that all their members should receive the same rate of wages. While they demanded the right of their members to refuse to work except on their

own conditions, they did not attempt to deny the right of any outside their ranks to accept the employment which they refused. By their organisation, by the moderation of their proceedings, by the power which the accumulation of funds gave them to withstand a lock-out or to bear a strike, they have been enabled to secure many privileges and concessions—such as increases in wages and reductions in hours of labour—for their members, and they have secured a control in the industrial life of the race which, properly exercised, is calculated to still further extend the sphere of their usefulness. In an evil hour, however, the control of the unions, especially in these colonies, has passed largely into the hands of men many of whom are professional agitators; the honest worker has exchanged the tyranny of an employer for the more oppressive tyranny of a mob orator. Not content with the right which they have now to dispose of their own labour on their own terms, the members of unions now want to refuse a similar right to all others. The tyranny of the old and often inhuman employers was the cold, cunning, secret tyranny of the few over the many. The tyranny of later day unions is the hot, violent, overbearing tyranny of the many over the few. The late maritime strike was an evidence of the readiness with which the slighest pretext is seized upon to provoke discontent; while the recent shearers' strike in Queensland proved that open rebellion against the law of the land and the commission of dastardly crimes are considered legitimate weapons in the warfare against capital. Any impartial survey of the history of strikes and lock-outs must result in the conviction that they have both failed to settle the conflict, and have both resulted in a waste of national energies and resources. Not only is this so, but the action of later day trade unions has tended to make the labourer less skilful and labour less effective and more costly. How can it be otherwise, when the trade unions require that the bad workman shall receive the same wage as the good one,—that the skilled artizan shall be allowed to do no more work in a day than the muddler? I say that the tendency of this attitude of the trade unions is to crush out all stimulus to exertion, to take away all encouragement to effort, to pull the expert down to the level of the blunderer, and not to raise the blunderer to the level of the expert. We have, indeed, seen fulfilled the prophetic utterance of Mr. J. S. Mill:—"We look in vain among the working classes in general for the

just pride which will choose to give good work for good wages: for the most part their sole endeavour is to receive as much and return as little in the shape of service as possible. It will sooner or later become insupportable to the employing classes to live in close and hourly contact with persons whose interests and feelings are in hostility to them." The condition has, indeed, become intolerable, and the encroachments of the trade unions have at last compelled capitalists to combine for their own protection. The two forces have gathered all their strength, and now stand face to face awaiting the struggle. Can the struggle be averted? We shall see.

It was probably the absolute and conspicuous failure of trade unions to harmonise the interests of employers and employed that led some social reformers to suggest coöperation as the panacea for the evil, and much confusion has arisen owing to a misconception of the aims and results of co-operation. Believers in this remedy for the industrial disease point with pardonable pride to the success which has attended the operations of distributive co-operative associations, starting with the conspicuous example of the Rochdale Society of Equitable Pioneers. This Society, which started in 1844 with a capital of £28, has achieved so marked a success that, according to Miss Beatrice Potter, its capital at the end of 1889 was £353,470, and its sales for that year £270,685. According to the same authority, there were in England in the year 1887 no less than 1516 societies of the Rochdale type, whose capital was £10,344,216, and whose sales for the year amounted to £34,483,771. These figures do not include such co-operative establishments as the Civil Service, the Army and Navy Stores, and such like. It is not difficult to account for the success of these organisations; the advantages secured to the customer by the saving of a large part of the expense of the middleman and the profit of the capitalist merchant is at once obvious. But when we come to deal with the question of productive co-operation the advantage is not so apparent, and we are not surprised to find that in this movement failure has been as conspicuous as success in the other. The idea of productive co-operation sprang from the brain of Robert Owen in the beginning of the present century, and was further developed by Ludlow, Maurice, and others known as the Christian Socialists, in 1849. In the British Economic Journal for June, 1891, Mr. D. F. Schloss gives a table embracing 1554 co-operative

societies. Of these only 119 are classed as productive. Referring to these societies, Miss Potter remarks :—" Associations of producers, on the other hand, start up at all places and at all times, arise and disappear like crops of mushrooms with perplexing rapidity, and frequently without trace." Miss Potter gives the history of the Christian Socialists' efforts in a few words: " Within a few years all the London and south country associations of producers, promoted or aided by the Christian socialists, had either dissolved without trace or degenerated into the profit-making undertakings of small masters." Singular to relate, however, the system of productive co-operation has been fairly successful on the continent of Europe. The pioneer of the system there, and perhaps the most successful experimenter, was the Parisian house-painter, Leelaine. Full particulars of his scheme, as of those of some 50 or 60 others, will be found in Mr. Sedley Taylor's work on " Profit-sharing." The experiment, however, as we have seen, has not found a congenial soil in English-speaking countries, and one is naturally curious to know why. In the first place there is a demand on the confidence of the great body of the workers in the skill and honesty of that small number to whom the general direction must necessarily be entrusted ; there is the obligation of obedience on the part of the mass towards the few who are in the same class as that mass ; and these are qualities which, to-day, are conspicuous by their absence among that great body which we invidiously style the working classes, subject as they are to the influence of professional agitators, who will not be likely to sit quietly by while their occupation is being taken from them. It is in the mutual distrust which the labouring classes have of one another—the indisposition to see one of themselves in a position of authority over them—that the greatest obstacle to productive co-operation is to be found. What I maintain is, that the greatest difficulty in the way of harmonising the relations of labour and capital lies in the fact that labourers and capitalists have both been taught to believe that their respective interests are opposed to one another. Generation after generation has been nurtured in this fallacy, and until it is exposed there can be no hope of a reconciliation; there may be a temporary truce, but never a lasting peace. Political economists are largely to blame for the existing misconception, and it is the duty of economic thinkers to remove it. Now, I say, both the Ricardian and Georgian schools are wrong in their definitions of profit and wages. I hold

the true definition to be that "profit is the value given to capital, and wages the value given to labour by the co-operation of the two forces of capital and labour." Let us illustrate this by a simple instance:—A labourer goes into the forest and fells a valuable timber tree. When he has done so he finds his labour has been spent in vain, because he cannot saw the wood into a marketable commodity, nor can he transport it to market. He discovers, however, one capitalist with a sawmill plant which he cannot utilise, because he can find no one with timber which requires sawing, and another with a team of horses for which he can find no employment. By a combination between the three, however, the labourer's timber is sawn and carried to market; the sawmill plant and team of horses are both employed; the two capitalists receive a profit for the use of their capital, and the labourer receives wages for his labour. I need not multiply this instance; the principle will be found to hold good in every walk and phase of industrial life.

In elaborating this theory we shall, of course, have to determine the respective shares of labour and capital in the final result. We shall also have to bear in mind that the line of demarcation between labour and capital is very faint,—that, especially in these colonies and in all young countries, the capitalist of to-day was the labourer of yesterday. I must, however, reserve the fuller treatment of these aspects of the question for some other occasion, and content myself now with little more than a definition.

Let us consider, however, what will be the effect of the acceptance of this doctrine in the industrial life of the nation. In the first place, it will tend to make labour more efficient, because the labourer will realise that he is a partner in the enterprise, and that his remuneration will tend to increase in proportion to the zeal and skill with which he applies himself to the performance of his task. In the next place, it will tend to induce the employer to provide the most efficient means to aid the labourer, to husband his strength, to make his circumstances as comfortable as possible, in order that he may be able to utilise his efforts to the best advantage. In the third place, by persuading both capitalist and labourer that their interests are mutually dependent, and not antagonistic, it will tend to make capital more productive and labour more efficient by the union of the two forces acting in the same direction instead of in opposite directions. It will at once suggest the introduction of a new dispensation,

in which the prediction of Mill, which I have quoted above, can find no fulfilment. It will expose the fallacy of the Ricardian dogma that, "as wages rise, profits fall," because it will show that a wise and prudent combination of labour and capital will make wages and profits both rise. It will confirm the conclusions at which Henry George arrived, while it will show the fallacy of the premises on which he based such conclusion, viz., "That all remedies, whether proposed by professors of political economy or working men, which look to the alleviation of poverty either by the increase of capital or the restriction of the number of labourers or the efficiency of their work, must be condemned." And, again, "Then wages cannot be diminished by the increase of labourers, but, on the contrary, as the efficiency of labour manifestly increases with the number of labourers, the more labourers, other things being equal, the higher should wages be." It will, furthermore, show that the great principle of co-operation, which has in the past presented such allurements and resulted in such disappointments, is, after all, the great motive power in an industrial as it is in our social and political life; that, rightly understood and intelligently applied, it suggests a remedy for our present unrest and a happy augury for our future development.

One word in conclusion. This section of our Association has an opportunity afforded to it of doing useful work in the development of our nascent nation. These young colonies, which have almost sprung into national existence, like Minerva full-panoplied from the brain of Jove, have inherited no legacy of misdeeds from the past, and furnish us with a favourable opportunity to make experiments in economic science. At the same time our position and our opportunities impose on us grave responsibilities. We are now making the last experiments in the responsible government of a young country which the world shall see; there is scarcely any other great unoccupied space on the face of the earth where the experiment can be repeated. In this particular, at least, we are—

> "The heirs of all the ages
> In the foremost files of time."

Shall we prove ourselves worthy of our destiny ?—Shall we embrace the opportunity offered? I, at least, have little sympathy with the Cassandra-like wailings of those who are evermore regretting the good old days that are past. I believe that the golden age of humanity is before us, not

behind us; I believe that in no land and at no time has the condition of the worker been equal in present comfort or in future hopefulness to that of his lot beneath the peerless glory of the Southern Cross. That there is grave discontent I have admitted; but I have endeavoured to show that it has arisen from a misconception which can be removed. We, at all events, should feel it a duty to so exert our influence and so use the opportunities at our command that, by wise and prudent counsels, by a fearless exposition of what we believe to be sound economic doctrine, both employers and employed may be led to realise that in harmony and not in conflict are to be found the true interests of all; that the welfare of both is to be secured by timely concessions, by mutual confidences, and by a decent burial of the animosities of the past. If my remarks can in any small degree aid in securing so desirable a result, I shall feel that the time devoted to them has been well spent.

NOTE.—Some of the views set forth above have been stated by me during discussions at the meetings of the Australian Economic Association. They are now for the first time presented in a connected form.

Section G.

ANTHROPOLOGY.

ADDRESS BY THE PRESIDENT,

THE REV. LORRIMER FISON, M.A.,

Queen's College, University of Melbourne.

To fill worthily the position which I have now the honour to occupy requires a knowledge of Anthropology far beyond that which I possess. I am only a specialist; and, since the work I have been able to do in my own line has had to be done in the intervals between pressing duties, I have been compelled to turn resolutely away from many by-paths of investigation which impinged upon my own and tempted me sorely to explore them. I shall therefore not presume to say anything about Anthropology in general, further than to commend the study of the science, in some one of its many branches, to those who have leisure hours at their disposal.

In these colonies, as we are sometimes reminded, we are business communities; we have scarcely any "leisured" class; business in one form or another is the lifework of nearly everybody, and very few have any time for other pursuits. But no man should allow any one occupation to fill his life and to shape his mind. It is because we are a business community—for that very reason—we ought to do something more and something other than our business, whatever it may be. A man's special occupation is his special duty, and has the first claim upon him, but it has no right to claim the whole of him, and he is most unwise if he admits the claim. To all men, and especially to young men, I would say, "Take hold of some branch of art or science, and make it the complement of your everyday work, and you will live to bless the man who gave you so excellent a piece of advice, and to be heartily glad that you had good sense enough to follow it." For Science is her own exceeding great reward, and all faithful work done for her earns in the work itself an ample wage.

The study of that particular line to which I devoted myself—the structure of the most Ancient Society—seems to me to be specially adapted to the leisure hours of a busy life. It requires no laboratory; it demands neither costly apparatus nor staff of assistants; it does not even need many books. A few volumes will show the student what is wanted in this particular line; and if he prefer to take up any other corner of the vast anthropological field, Dr. Tylor's admirable manual, entitled "Anthropology: An Introduction to the Study of Man and Civilisation," will lay a wide choice before him.

Then, again, good work in this line can be done without any special training. Any fairly intelligent man who is willing to give patient study to it, cannot fail to do work of solid value. Not, indeed, work that will pay from a university examiner's point of view, for our universities offer nothing to the student of Anthropology—Greek roots to them are more precious than are the roots from which Attic society grew—but work that is of great value as ministering to that kind of education which teaches the student to *know*.

It is a mistake to suppose that this study would be an addition to the burdens of the already overburdened student. "It will be found," Dr. Tylor well says, "that the real effect of Anthropology is rather to lighten than to increase the strain of learning. The science of man and civilisation connects into a more manageable whole the scattered subjects of an ordinary education. Much of the difficulty of learning and teaching lies in the scholar's not seeing clearly what each science and art is for—what its place is among the purposes of life. If he knows something of its early history, and how it arose from the simpler wants and circumstances of mankind, he finds himself better able to lay hold of it than when, as too often happens, he is called upon to take up an abstruse subject, not at the beginning of it, but in the middle. The dislike of so many beginners to geometry as expounded by Euclid, arising from the fact that not one out of three ever readily understands what he is doing, is, of all things, due to the scholar not being shown first the practical common-sense starting-point, where the old carpenters and builders began to make out the relations of distances and spaces in their work. So, also, the law student plunges at once into the intricacies of legal systems which have grown up through the struggles, the reforms, and even the blunders of thousands of years; yet he might have made his way

clearer by seeing how laws begin in their simplest forms, framed to meet the needs of savage and barbaric tribes."

To illustrate this, I may point to the astonishing light which present day custom, now discoverable in savage tribes, throws upon ancient history. Thus, the late Mr. J. F. M'Lennan pointed out that the totem explains many of the Greek legends—such as the hunting of the Kalydonian boar; the oracle enjoining Adrastus to give his daughters in marriage, one to a boar, the other to a lion, and many other instances. I shall probably startle some of you if I say that the local and the social organisations of our own Australian aborigines have thrown much light upon vexed questions connected with Attic society—upon the deme and the phratry, the genos, the status of aliens, and even upon the Areiopagus itself: yet such is the undoubted fact. For, to quote from an article by my friend and fellow-worker, Mr. Howitt, and myself, "It can be shown that Athenian society was built upon an old foundation, whose outlines, and even whose inner dividing lines coincide substantially with those of savage society, and these lines can still be distinctly traced. The stately edifice of civilisation reared itself upon them, and it was their arrangement which determined its general form." Even to theology itself this line of inquiry ministers, and the student of Old Testament history will find himself wonderfully helped by it.

Our own modern civilisation, too, is full of fossilised anomalies, which by the aid of savage custom can be traced back to a time when they were full of life. Thus, if Buckle had studied savage life and custom before he began to write his pretentious book, he would never have called pride of birth a mere "ecstacy of the fancy." He would have seen that it is not

> "a false creation,
> Proceeding from the over-heated brain,"

but a direct inheritance—a "survival in culture" (to use Dr. Tylor's apt phrase) of an old savage notion which, however absurd it may be among ourselves, was perfectly reasonable in its day, when the man who was not both freeborn and fullborn had only a very inferior status in the community, while he who was neither one nor the other had positively no status at all. So also the crests of our armorial bearings have little or no meaning to us now, but they can be traced back to a time when they represented the ancient totem, which had a powerful function in the older of the old com-

munities, as it has among many savage tribes of the present day.

Another consideration which seems to me to commend my own line of research is *the completeness of its evidence.* In the investigation of the framework and structure of Ancient Society we have to go back a long way beyond the point at which Sir Henry Maine begins in his Early History of Institutions, for there is a history of them far earlier still, and we can get at much of it by patient examination of savage tribes who are within our easy reach. To quote words which I wrote many years ago: "They unfold to us that history which is before history, and which calls up the shadowy forms of the long-forgotten past, clothing them with substance, marshalling them into order, and revealing to us the stages of their onward march. For in the present condition of savage tribes we see the infancy—or rather the childhood—of (to use Dr. Temple's grand conception) 'that colossal Man, whose life reaches from the Creation to the Day of Judgment; in whose existence the successive generations of men are but as days; whose works are the discoveries and inventions which characterise the different epochs of the world's history; and whose thoughts are the creeds and doctrines, the opinions and principles of the successive ages.'

"Here we have, not merely as it were, a bone or two of an extinct animal found under the stalagmite floor of an ancient cave that was eaten out of the solid rock by streams which have long since forgotten to flow, nor a flint tool dug out of the old river drift—fragmentary bits of evidence which, after all the skill and care used in piecing them together, leave much to conjecture, and much open to doubt in the reconstructed whole; we have the earlier period actually reproduced almost in its completeness before our eyes. It is as if the old-forgotten time, before historians began to write, were placed side by side with the new, showing us, where now are crowded cities, and clanging factories, and cultivated fields, vast herds of wild animals roaming over untilled plains, or crashing through virgin forests, skin-clad tribes pursuing them with weapons of stone, and hyenas dragging into their caves the bones of the victims slain by the nobler beasts of prey."

We are indebted to the strong conservatism of savage tribes for this reproduction of the past. The savage, when once he has become *set*, so to speak, is a conservative of the conser-

vatives. He encases himself, as Walter Bagehot says, in "a hard-shell of custom," the main form of which is unalterable. At all events he never willingly alters it, and when he is compelled to change he pretends that the new form is in accordance with the old pattern. And this is perfectly logical and reasonable from his own point of view. For custom is the tried and approved law of life, which has been handed down to him by his ancestors, and they are his gods. It has therefore to him all the force of divine law, the breach of which will certainly be followed by terrible consequences affecting the whole community. To quote once more from that article of mine: "Life to the savage is a sort of charmed circle, of which custom marks the never-changing circumference. Within there is safety, but the terrible unseen powers are on the watch outside. Hence comes an unvarying sameness from generation to generation, as long as the surroundings remain unchanged. The same thing is done over and over again in the same way, because it is customary and therefore *safe*. Experiment is a thing to be utterly abhorred and put down with a strong hand. No man can be a free agent, for what he does involves the whole community. He is not at liberty to choose what he shall be or what he shall do. Every man must be what his father was; he must do what his father did, and he must do it in his father's way. In short, he must keep on the rails, for if he leave them he may drag the whole train to destruction."

Among ourselves a man desirous of testing the explosive powers of nitro-glycerine may be allowed to follow his bent as long as he keeps his distance; but if he were discovered making his experiments in the powder magazine of a line-of-battle ship, with all the crew on board, or in the midst of a crowded market-place, it would not be easy to keep those whose lives he had endangered from taking summary vengeance upon him; and they would feel towards him precisely as a savage tribe feels towards an innovator. According to their notions, such a man puts them all in peril of their lives, and they must hasten to mark their disapprobation of his action in such a way as to save themselves if possible. To do this they take the shortest and most effectual way—they wipe him out. No such thing as a "Liberal party" is possible among savages. The conservatives have it all their own way, and they take care that there shall be none but conservatives extant.

This line of research commends itself also by the excellent

discipline of it. It teaches the student—sometimes by painful lessons—to be cautious, steadfast, and to wait. It requires a vast amount of patient work, covering a very wide field, and collating and comparing facts from every part of it; for the student soon finds that it is very dangerous to generalise from the facts discoverable in any one locality. No two tribes are exactly alike. They may have started from the same point, but they have not all come by the same road, and we do not find them all in the same stage of the journey. In many cases the differences are only superficial, or at least not far down below the surface, and yet they sometimes present so great a dissimilarity of appearance that nothing short of a very close examination can determine the original identity. "It is" (once more to quote my own words) "as if some plastic material had been forced into roughly fashioned moulds of the same shape, but each with cracks and flaws peculiar to itself. The cores would be alike in the main, but the surface irregularities might be so dissimilar as to make it hard to believe that the moulds were of the same pattern; and these outer differences are made all the greater by the fact that the mass is not composed of inanimate material. It is organic—it has life in it. The excrescences *grow*, and their growth exaggerates the original divergences. With infinite trouble civilisation rubs off these excrescences, but the roots of them remain even in the most highly-civilised nations; and, however closely they may be worn down, they often retain vitality enough to *sprout*, and to throw out queer little shoots of the old pattern—survivals in culture of old savage notions."

I have said that "we do not find all the tribes in the same stage of the journey," and this implies that we *do* find them all on the way. Stationary as they are now—or at least as they appear to us because their progress, like that of the so-called fixed stars, is imperceptible to us as we watch—yet it is evident that, with the exception of a few wretched war-driven remnants, they *have* progressed. The Degradation Theory finds no support along this line. Examining, for instance, the organization of a people like the Fijians, we perceive unmistakable traces of a lower grade on which it is an advance. In this lower grade we find a people somewhere else, on whom also are plainly to be seen the tokens of an upward movement, and so on for several stages downwards, until we reach the lowest at present known, and even there

we find the traces of a lower still. This is no fanciful interpretation of signs which may have another meaning, or indeed no meaning at all. The marks are as significant and as easily read as are the signs of his calling on the clothes and person of the miner when he comes up from his work: anyone who sees him can tell what his calling is, but those who are versed in such matters can point out the very locality where he has been at work. Nations carry with them shreds and patches of their left-off clothing, each of which, like the hanging sleeve of the hussar's jacket, or the martial buttons on the back of a peaceful citizen's coat, has a definite historical meaning for us if we can only read it.

In these investigations two things mainly are required—first, a patient continuance in the collecting of facts; and, secondly, the faculty of seeing in them what is seen by the natives themselves. We must ever remember that our mind-world is very different from theirs. It is not filled with the same images; it is not governed by the same laws. It is to theirs as the England of the present day is to the England of who shall say how many ages ago? The climate, the coast line, the watersheds, the flora, the fauna—in short, nearly all the aspects of nature—are changed. It is to all intents and purposes another land. As to the former of these two requisites, one's natural tendency, especially in the beginning of the work, is to form a theory as soon as one has got hold of a fact; and, as to the latter, we are too apt to look at the facts in savagery from the mental standpoint of the civilised man. Both of these are extremely mischievous. They lead investigators into fatal mistakes, and bring upon them much painful experience; for the pang attending the extraction of an aching double tooth is sweetest bliss when compared with the tearing up by the roots of a cherished theory. I speak feelingly here, because I can hold myself up as an awful warning against theory-making. To take one instance only. In *Kamilaroi and Kurnai*, the joint work of Mr. A. W. Howitt* and myself, there is a long chapter containing a most beautiful theory of the Kurnai system, which I worked out with infinite pains. It accounts for that system so completely and so satisfactorily that the

* It is only bare justice to Mr. Howitt to note that nearly all the labour of collecting the Australian facts fell to his share, and that he did this work after the manner in which he does all other work undertaken by him. No higher praise could possibly be expressed.

Kurnai ought to be ashamed of themselves for having been perverse enough to arrive at their system by a different road, which further inquiry showed us most conclusively that they did. Students of anthropology who have read our work, and who still survive, will please accept this intimation that the theory aforesaid is not worth a rush.

Even more mischievous is the habit of looking at the facts in savagery from our own standpoint. Some of our modern anthropologists' books are full of errors arising from this evil habit—errors which are "gross and palpable" to any one who has lived long among savages, and taken the pains to learn to see with their eyes. "You can feel the mistakes with a stick," said a good Lutheran missionary, one of Mr. Howitt's correspondents, who had been reading the statements about the Australian blacks in a work which is generally considered to be of great authority, and has passed through many editions. To get at the real meaning of the facts we must learn to see in them what the savage sees, and in order to do this we must get out of our own mind-world and into his. We must unlearn before we can begin to learn. It is the lack of this which makes the evidence—or, rather, the opinions—of the mere passing traveller so extremely untrustworthy. As long as he confines himself to telling what he has actually seen, his statements, if he be a truthful man, are of value, but as soon as he begins to talk about what is *in* the facts, in nine cases out of ten he is sure to go far astray.

The best way of getting at the meaning of the facts is to go and live with the natives long enough to learn their language and to thoroughly gain their confidence—say, from ten to twenty years; but, as this is impossible to all but a very few, the next best way is to get information from the men who *are* living among them. This can be done by correspondence, and my own experience shows that men are to be found who are willing to give information and to prosecute inquiry—in Australia, squatters, police-troopers, and others who have aboriginal tribes still living in their neighbourhood—and missionaries and traders in the South Sea Islands. There is still a large unworked field in Australia, and I venture to indulge a faint hope that these words of mine may possibly induce a student here and there to take up the work which both Mr. Howitt and myself have been compelled by the stress of other occupations to lay aside, at least for the present. The tribes are rapidly dying out, and with

them is perishing information of the highest anthropological value. There is a still larger field in the New Hebrides, the Solomons, New Britain, New Ireland, and other island groups. Some of these are of special interest because of a real money currency among them—shell money—which has a great influence upon the lives of the people. This "commercial savagery," as I have called it—and I see the term is being accepted—is full of interest, and needs investigation.

There is one piece of good work which any fairly intelligent young man could do. Scattered here and there among all manner of books on Australia there are references to the aborigines—sometimes a mere passing reference in the narrative of some incident in which natives were concerned, and, in other cases, more or less ample descriptions of something or other in their mode of life. These require collecting and classifying. What is needed is for some one to go, say, to the Melbourne Public Library, and afterwards to one or two private libraries, in which these books are to be found; to look through every one of them which he can find on their shelves; to make extracts of all passages which bear upon native custom and beliefs, and, finally, to arrange the extracts under certain heads. The work will become more and more interesting as it grows under the student's hands. At all events, either the facts will continue to be to him what they are very likely to appear to be at first—mere unconnected dry bones, the driest of the dry; in which case he had better cease from his labour and turn to something else—he has not the anthropological soul; or he will see the facts grouping themselves into living forms; they will become articulate, and speak to him if he has ears to hear, and, when he has once heard their voice, he will need no more persuasion from me, or from anybody else, to continue in the work.

I cannot conclude my address without pointing to the magnificent and all but untrodden field which we have before us in British New Guinea and its outlying groups of islands. There is, probably, no richer field for the anthropologist on all the face of the earth. Sir William Macgregor informs me that he has not found among the tribes there any of the exogamous intermarrying divisions which exist almost everywhere else, and which are found in islands—New Britain, for instance—near to the New Guinea coast. The people, to use his own expressive phrase, are in a state of "fermenting savagery," and have not yet got moulded into any of the

familiar forms. This fact is of the greatest importance. There is another fact which also is full of promise. Up to a certain point on the Fly River, the great stream which Sir William has navigated and explored to a distance of 600 miles from its mouth, there are settled agricultural tribes; but above that point the people seem to be nomad hunters, though it seems likely that there are also settled tribes in the country back from the river. These nomads come down to the river banks at a certain season of the year and plant food, remaining for some months on the ground, and living in rudely constructed temporary huts. Here, then, we have nomad tribes on their way to agricultural settlement, and their customs will present points of special interest and value. I may add that Sir William and his staff lose no opportunity of collecting information of all kinds. His splendid reports abound in vivid narrative and description, and they are full of valuable facts. They have appendices also on the flora and fauna of the country, vocabularies of the dialects, maps and drawings, which, like all the work he is doing, are thoroughly well done. Sir William Macgregor is a man of whom we should all be proud.

It only remains for me to notice two extremely valuable books touching our own Australasian field, which have been published since our last meeting—the Rev. Dr. Codrington's admirable work on the Melanesian Tribes which was issued from the Clarendon Press, and the Maori-Polynesian Comparative Dictionary, by Mr. Edward Tregear of New Zealand, a Vice-President of this Association. His dictionary gives the existing related forms of words common to New Zealand and the Polynesian Islands: it is copious, scholarly, accurate, and altogether of the very highest value.

Section H.

SANITARY SCIENCE AND HYGIENE.

Address by the President,

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"Sanitary Engineering, as applied to the Drainage of Cities and Towns, and the Disposal of Sewage and other Refuse."

It is my first duty to thank you for electing me President of this important Section. I assure you that I fully appreciate the honour you have done me, but am at the same time aware of the responsibility involved in my acceptance of the position, which includes, among other things, the delivery of an address on some subject connected with Sanitary Science and Hygiene.

The eminent men who have presided over this Section during former meetings have all belonged to the medical profession, and their addresses were devoted to the following subjects:—

"Various Hygienic Aspects of Australian Life," by Dr. Bancroft; "The Practice of Preventive Medicine," by Dr. Ashburton Thompson; "The Advance of Sanitation among the People," by the Hon. Dr. Campbell. My choice of a subject upon which I may hope to interest you is necessarily limited by the profession to which I belong, and Sanitary Engineering is, therefore, the branch from which I must select the subject of my address. Sanitary Engineering embraces the methods for removing and safely disposing of the various wastes, both liquid and solid, of domestic and industrial life, and the construction of the necessary works and appliances by which these may be accomplished. It has for its object the production of such conditions of air, soil, and water as shall be most congenial to the health of the community.

Sanitary Engineering is of ancient origin. The underground works discovered at Jerusalem, and the Cloaca Maxima at Rome, as well as the remains of similar ancient works in other parts of the world, clearly indicate that the Jews and the Romans at least were fully alive to the necessity of removing all decomposing matter and filth to places beyond the city. Mr. B. Latham, in his work on Sanitary Engineering, states that, "Although these ancient examples of sanitary works were executed when art and science had reached a high degree of excellence, we come to a period in history when both art and science declined, and with them the prosecution of those sanitary works which were of so beneficial and useful a character; in fact, the benefits derivable from Sanitary Science seem to have been forgotten and ignored, and the people sunk to lowest depths of sanitary neglect, from which the powerful voices of plague, typhus, and cholera were the first to arouse them."

Sewerage and improved house drainage have done more than anything else to lower the death-rate in England. Sanitary measures of this character are most efficacious in preventing and controlling such diseases as enteric fever, cholera, and diarrhœal diseases. Asiatic cholera has frequently been introduced into cities in Europe, but it has always failed to secure a foothold in those cases where the sanitary arrangements and the cleanliness of the people have been satisfactory.

It has been frequently argued by competent authorities that the neglect of sanitary precautions not only causes an increase in the death-rate, but also a loss of even greater importance, in the decreased vitality of the community.

Sanitary Science has made rapid progress during the last forty years, and it is at present exciting much attention in all parts of the civilised world. Old theories and methods have had to be abandoned, and new ones substituted for them. Both theory and practice are far from perfect, and must be modified as knowledge advances; but the tendency is, undoubtedly, in the direction of improving the conditions under which we live.

The organic waste products of our life which have been referred to tend to contaminate the air, soil, and water. They may not be offensive when first produced, but they rapidly become so, and in the process of decomposition they become powerful agents to do harm. It matters not whether these wastes consist of animal or vegetable matter, or whether they

have passed through the human system or not, they ultimately become dangerous, and should be removed before decomposition has had time to commence.

It is now generally admitted that the best means of removing liquid wastes, such as the discharge of kitchen sinks, waterclosets, urinals, baths, and the various foul liquids which flow from industrial establishments, is by water-carriage; but water-carriage is quite incapable of dealing with garbage and house refuse. It is not the best means of removing ordinary street sweepings or manure; it is, therefore, necessary to supplement the water-carriage system, where it is adopted, by a systematic removal and destruction of garbage and other refuse, such as the offal of slaughter-houses, condemned food, diseased animals and manure, the accumulations of yard and street gullies, the sweepings of streets, and other offensive matter which is not admitted into sewers. The almost universal system existing in these colonies of filling up old quarries and raising the level of low-lying land by means of such organic refuse is obviously most objectionable, since these places become centres for the spread of disease, and the evolution of noxious and dangerous gases resulting from the decomposition of the refuse, which exercises a most prejudicial influence on the health and well-being of the inhabitants of the surrounding districts. Where the water-carriage system does not exist, or wherever the nightsoil has to be dealt with by any system other than that of water-carriage, it is necessary to provide for its removal and ultimate destruction or conversion into poudrette manure in a safe and unobjectionable manner.

It being admitted that water-carriage is the most practicable plan of dealing with liquid and semi-liquid household wastes, it remains for me to consider somewhat more closely the details of the system. It should, however, be remembered that while well-designed and well-constructed sewers, with an ample supply of water, may be regarded as perfect from a sanitary point of view, if they are badly arranged and badly constructed they become fearful agents of destruction.

Mr. Waring, one of the highest authorities on Sanitary Engineering in America, states that the requirements of a good sewer should be as follows:—

"1. It must be perfectly tight from one end to the other, so that all matters entering it shall be securely carried to its outlet, not a particle of impurity leaking into the soil.

"2. It must have a continuous fall from the head to the outlet in order that its contents may be kept moving, so that there shall be no halting to putrefy on the way, and no depositing of silt that would endanger the channel.

"3. It must be perfectly ventilated, so that the poisonous gases that necessarily arise—even when decomposing matters are being carried along in water—shall be diluted with fresh air, and shall have such means of escape as will prevent them from forcing their way into houses through the traps in the house drains.

"4. It must be provided with means for inspection and flushing.

"5. The branches by which it receives its supply should be so regulated as to admit nothing that will be liable to choke up the channel.

"6. There must be some device to prevent the gases of the sewer from rising through the house drains or through the street basins.

"7. Its size should be so adjusted to its work that it will remove all water that ordinary rains bring to it, and so that the usual dry weather flow shall keep it free from silt and organic deposit."

Mr. Waring considers that any sewer deficient in any one of the first six requirements is a fair subject for indictment as a dangerous nuisance. In designing a system of sewerage for a given town, one of the first things that has to be considered is the greatest quantity of fluid which the sewers will be required to discharge. Now, it is clear that the sewers must be capable of discharging all the liquid wastes which will be delivered to them, which is usually estimated by assuming that they are equal to the water supply which is most conveniently estimated in terms of the population using the sewers. The volume of sewage to be provided for depends upon the water supply, and allowance must also be made for half the daily quantity flowing off in six hours.

Now, there are various systems which have been proposed for the sewerage of towns, which may be described as follows :—

a. The combined system, in which both surface and subsoil waters are admitted to the sewers in addition to the sewage.

b. The separate system, in which surface and subsoil waters are completely excluded, and are each provided for by separate drains.

c. The partially separate system, in which a certain quantity of storm-water is admitted into the sewers, generally that falling on the back roofs and yards of houses. The surface and subsoil waters are each disposed of by separate drains as in the separate system.

d. A system proposed by Captain Liernur, in which the surface and subsoil waters are dealt with separately, the liquid wastes separately, and the solid excreta separately; the solid excreta is removed by cast-iron pipes, in which a vacuum is created by means of engines and air-pumps at a central station, where furnaces are provided for converting the material conveyed by the cast-iron pipes into a poudrette manure.

e. Shone's system, which consists in dividing up a town into a number of districts, each with its separate outfall and discharging station, the discharge from all the stations converging into one common main leading to the ultimate common outfall. This system is applicable when the rain-water is entirely excluded, or when it is admitted to a limited extent.

I will first deal with the three separate and combined systems.

From a mechanical point of view, the combined system performs all the offices required of it in a more or less satisfactory manner, but the disadvantages are obvious. The admission of subsoil water necessitates porous joints, and in times of drought the sewage will flow outwards and contaminate the ground. The large size of the sewers necessary to convey storm-water renders them most insanitary during the dry weather flow, owing to the large surface exposed to decomposition. Again, the surface waters carry with them during heavy rains much sand and silt, which remains to some extent afterwards, forming a nucleus for the deposit of the solid portions of the sewage and subsequent decomposition, resulting in the generation of foul gases, which may increase in pressure sufficiently to force the traps of the house drains. The street gully catch-pits become most offensive, as they are local centres of decomposition, intercepting as they do the horse manure, mud, and street sweepings, whereas these

substances ought to be removed by a proper system of scavenging. The partially separate system is in greater favour in England, and it is certainly not generally attended with the disadvantages of the combined system. The rain-water from the back roofs and yards does not carry any large quantity of silt, and where the gradients are such as to render the sewers self-cleansing with the dry weather flow, no difficulty from this source need be anticipated. The main objection to the partially separate system consists in the large increase in the volume of fluid to be provided for, so that during dry weather, when only the sewage is being discharged, there is a considerable volume not occupied by sewage in which sewer gas accumulates. The flatter the gradient the greater this volume will become, and where, as too frequently happens, the velocity of the dry weather flow is insufficient to prevent deposit, the sewers become insanitary, and the health of the community using them necessarily suffers. If in any proposed scheme for drainage the sewers are laid at such gradients that they cannot be self-cleansing with the dry weather flow, then it is clear that the scheme is unsatisfactory, and should be modified so as to ensure this self-cleansing velocity. These remarks apply also to the separate system, excepting that the smaller size of the sewers leave a less volume for the accumulation of sewer gas and automatic flushing by means of specially constructed tanks may and have been successfully applied to prevent and remove deposit resulting from insufficient velocity.

The Liernur System has been applied to one or two towns in Europe, but it appears to me to be expensive and unnecessarily complicated. The separation of the solid excreta from the liquid household wastes is, in my opinion, a great mistake, since both consist of organic matter, which in decomposing become offensive and dangerous. The so-called earth-closet system, which is so largely employed in Australia, leaves the liquid household wastes with their burden of organic matter to be dealt with, which is usually done by discharging them into the surface gutters, creating the nuisance with which we are all familiar.

Shone's Hydro-Pneumatic System possesses the advantage of dealing most efficiently with the sewerage of flat and low-lying districts, where it is impossible for the Sanitary Engineer to design gravitation sewers, pure and simple, which shall carry away the sewage discharged into them freely and innocuously to one outfall, whether that outfall be

a pumping station, a sewage farm, or situated in the estuary of a river, or the ocean. The district is divided up into sections, in which pipe sewers are laid at the most suitable gradient to ensure sufficient velocity to render them always self-cleansing. This is readily done by sinking, in a central or some other convenient position within the various sections, pneumatic ejector stations. To these, as to a steam pumping station, the sewage would flow quickly through the gravitation sewers, which, being of comparatively short length, the sewage from the house furthest away from the ejector station could not fail to reach it in a fresh and undecomposed condition. These sewers are flushed daily by automatic flush tanks. The ejectors raise the sewage delivered to them up to the level of the main outfall sewer, which may discharge by gravitation, or with the assistance of the air pressure. The ejectors are supplied with compressed air from central pumping stations, arranged in the most convenient manner to suit the district under consideration, and they receive and eject the sewage as fast as it is delivered to them, working automatically.

It frequently happens that certain low-lying districts cannot be conveniently included in the general scheme of main drainage for a city or town, in which case Shone's System enables the engineer to deal with the low-lying districts, and raise the sewage up to the level of the main gravitation sewers; but when applied in this way it is comparable with the following methods of raising sewage:—

a. By means of Cornish, Worthington, or other Pumping Engines.

b. Mr. Baldwin Latham's Hydraulic Pumping System.

c. Mr. Waring's System of Syphonage, such as used successfully at Schiedam, Holland.

The drainage of the subsoil is most important, and subsoil drains may be conveniently laid in the same trench as the sewer proper, but they should be made to discharge into the natural creeks and water-courses in preference to the sewers.

The success of the water-carriage system will not be complete unless both the main sewers and house drains are efficiently ventilated; for while it is necessary to remove decomposable matter as rapidly as possible it is also important to provide means for modifying decomposition and diluting and removing the gaseous products. This is attained, where the house drains discharge into pipe sewers, by making the soil pipe itself a ventilator, reaching above the roof and

connected to the main or lateral drain without a trap. The lateral drain may be ventilated by means of a cowl at one end forcing air downwards, and an open pipe at the other for discharging the diluted gases into the atmosphere.

Manholes about every 1000 feet to the main sewers provide a supply of fresh air, and assist in the discharge of sewer gas.

The ventilation of large sewers is by no means a simple matter, and there appears to be no better method than providing gas checks and a drop in the gradient at every manhole, so as to ensure as far as possible the discharge or supply of air at every manhole. The omission of the trap in the house drain at its junction with the main sewer facilitates ventilation, and is perfectly safe if the sewers are properly designed, constructed, and maintained, but it may be in some cases dangerous to omit the trap. The house fixtures are trapped from the house drain, so that the dilute sewer air is discharged above the roof only, and is not at all likely to force the house traps. The movement of air in the sewers depends upon differences in temperature between the air outside and inside the sewer, also upon barometric changes, effect of wind blowing across the outlets connected with the sewer, the effect of heat on the soil pipe ventilator, and the fluctuations in the flow of sewage.

I will now direct your attention to a few examples illustrating the subject so far as I have considered it. The City of Adelaide was the first in Australia to adopt a complete system of sewerage, which was designed and carried out by Mr. Oswald Brown, M. Inst. C.E., on the partially separate system. The Hon. Dr. Allan Campbell pointed out in a paper read before this Association in Sydney that the ventilation of the Adelaide sewers was defective, and he suggested the omission of the trap between the house drain and the main drain, so as to make better use of the soil pipe ventilators. I had some doubts at the time the paper was read, but I now concur with Dr. Campbell. Before the sewerage system was in operation in Adelaide it was the most unhealthy city in Australia, whereas now it is the cleanest and one of the healthiest. The sewerage of Sydney has been fully described in my paper read before this Association in Sydney, "History of Civil Engineering in New South Wales." I will now only briefly refer to it. There are three main divisions. The Northern Section, draining five thousand three hundred acres, discharging by means of an intercepting sewer at a point on the ocean cliffs, about $3\frac{3}{4}$

miles from the South Head, and known as Ben Buckler's Point. The Southern Section, draining eleven hundred acres, discharging at Botany on a sewerage farm. The Western Section, draining about 31 square miles, will also when completed discharge at Botany on a sewerage farm. The intercepting sewer discharging at Ben Buckler's Point receives the discharges of many old sewers which formerly discharged into the Harbour. These old sewers were designed on the combined system, and carry much silt from the street gully shafts. In times of heavy rain the diluted sewage escapes over a weir at Rushcutters' Bay into a storm-water channel, discharging into the Harbour. The practice in Sydney with new sewers is to exclude surface water as much as possible. The sewerage of Dunedin appears to me to be much in the same state as the sewerage of Sydney before the intercepting sewers were constructed, and they receive storm-water through street gulleys, and are good examples of the evils of the combined system. The Engineer, Mr. S. H. Mirams, informs me that the city is divided into five Drainage Districts, each provided with a main intercepting sewer, discharging into the Dunedin Harbour. Up to the present £42,000 has been expended on drainage. Mr. Mirams proposes to construct an intercepting sewer to receive the discharge of the five intercepting sewers referred to, and convey it to the ocean beach. The fall of this main trunk sewer is not sufficient to discharge the water from the city at the ocean by gravitation alone, and consequently the sewage, when collected at a certain point, must be raised by artificial means. It is proposed to exclude storm-water as much as possible from the main trunk sewer, and to provide means for discharging flood-waters and dilute sewage from the present sewers into the Harbour. I merely mention that it may be more satisfactory to use these five sewers as storm-water drains only, and to design a complete system of drainage on the separate system, taking advantage of Shone's System of elevating the sewage of the low-lying portions.

The sewage of Wellington has been reported on recently by Messrs. Cuthbert and Ferguson, and they have recommended the adoption of the partially separate system, with Shone's method of pumping the sewage from low-lying districts. The drainage of Christchurch was designed and carried out by Mr. Napier Bell, M. Inst. C.E., but the works are now in charge of Mr. Cuthbert, M. Inst. C.E.

A report has been just published on the proposed sewerage

of Melbourne by one of the most eminent of the English Sanitary Engineers, Mr. Manserg, M. Inst. C.E., who is also a Member of the Council. Mr. Manserg proposes the partially separate system, and to admit rain-water from the back roofs and yards of houses; also to pump the sewage at two separate stations to a sewage farm. He proposes several very large sewers—two are about 14 feet in diameter, and these converge into another, which on the same basis would require to be about 20 feet in diameter. Several of the sewers are proposed to be laid at gradients which are not steep enough to render them self-cleansing with the dry weather flow, especially when the system would first come into operation.

A critique on Mr. Manserg's Report has been published by Mr. Shone, in which it is attempted to prove that Mr. Manserg's scheme is unsatisfactory, and that Melbourne could be much better drained on the Shone System. I recommend all those interested in the subject to study the reports. Having in view the difficulties of obtaining good natural gradients in Melbourne, and the fact that the present surface drains discharge surface waters as well as the liquid household wastes, it appears to me that the storm-water might have been excluded to a much greater extent than proposed by Mr. Manserg, resulting in smaller sewers. The present surface drains would be suitable for discharging surface waters freed of household wastes, and probably Shone's System might be found most economical in overcoming the difficulties with regard to natural gradients where they exist. It would be easier to flush and ventilate the smaller sewers and maintain them in a better sanitary condition. There is no doubt in my mind as to the partially separate system being as good as the entirely separate system where good natural gradients are obtainable; but I consider it desirable to point out a few of the advantages of the separate system, as applied in the first place at Memphis, and afterwards in about 30 American towns. I will quote the remarks made by Sir R. Rawlinson on the sewerage of Memphis. He says that "the sewers were so small and so well filled by the flow of sewage, that there is very little exposed wall-surface for bacteria to germinate, and very little space for storing up germ-laden air. The gases and heat of decomposition, which so powerfully stimulate organic life, are prevented by the daily flushing which is only possible in small sewers. The smooth glazed surface of the pipes is unfavourable soil for

vegetable growth compared with porous bricks moistened with sewage."

It must be conceded that rain-water in excess is inconvenient, and in some cases may do considerable damage, but it may certainly be allowed to flow off the surface by means of the ordinary surface drains, and it is far better to construct special storm-water channels to relieve low-lying districts than to admit storm-water into sewers. These storm-water channels will only be necessary for probably one-fifth of the length of the sewers, and they need not be constructed at so low a level. Where sewage has to be raised by artificial means is is obviously an advantage to keep the volume constant and reduce it to a minimum, which means the exclusion of rain-water. Again, in the chemical treatment of sewage, or its disposal on a sewage farm, it is most desirable to avoid the uncertain volume of fluid due to rainfall, which in the case of a farm comes at a time when the ground is saturated and least requires irrigation. It follows, therefore, that in many inland town in Australia the separate system would be the most convenient and economical, as it has proved to be in America, provided that the upper end of each branch sewer is provided with an automatic flushing tank of sufficient capacity to secure the thorough daily cleansing of so much of the conduit as from its limited flow is liable to deposit solid matters by the way. In Sydney, Dunedin, Wellington, Auckland, Hobart, and other similarly situated towns, there exists a considerable area round the harbours which cannot be included in a purely gravitation scheme, and which could be most conveniently and economically dealt with on Shone's system, and I believe that this system will be largely used in Australia and New Zealand in future sewerage works.

The position of the main outlet or outlets has an important influence on any scheme of sewerage. If the town is situated near the estuary of a rapid tidal river, or near the sea, so that the sewage may be discharged without creating a nuisance, it generally becomes the most economical method of disposal. As to whether sewage may be safely disposed of by discharging into a tidal river, the question can only be decided with reference to the volume and velocity of the river and the quantity of sewage it is proposed to discharge into it. We must clearly distinguish between the contamination of a well where the water is stagnant and the air not frequently changed and the conditions existing in a rapid

river. The sewage from two millions of people is discharged into New York Harbour, but the volume and velocity of tidal water is exceptionally great and the result fairly satisfactory. At Brighton, England, and at several other seaside towns, the outlets have proved unsatisfactory because of the return of the sewage on to the beaches, so that very expensive conduits for removal to suitable distances have become necessary. The sewerage of the Northern section of Sydney discharges into the ocean in deep water, and there is no nuisance, or prospect of a nuisance, from this method of disposal.

Chemical Precipitation Processes have been applied to render the effluent sufficienly pure to discharge into a river, but these are only partial, as they leave the precipitated impurities known as sludge to be dealt with in some other way. The purification of the effluent is more apparent than real, and it rapidly decomposes if allowed to remain stagnant. The sewage is collected in tanks, and lime, salts of iron, alumina, or other coagulating or precipitating agents are added, which precipitate the suspended and some of the dissolved matters as sewage sludge. The sludge contains about 90 per cent. of water, and in the case of the London sewage it is pumped out of special settling tanks into sludge barges and discharged under water far from land. The clear effluent is discharged into the Thames some miles down the river. Sludge may be dried to reduce its bulk, or completely destroyed by fire in a specially constructed furnace. Or, again, it may be pressed so as to reduce its bulk and render it more easily conveyed by cartage. It has about 1-7th of the value of ordinary sewage as a manure, and may be dug into the ground on a farm. In any case it must be specially dealt with, as it becomes very offensive. Chemical processes can hardly be considered satisfactory.

In inland towns, and wherever the expense of discharging the sewage out to sea is greater than that of disposing of it on a sewage farm, the latter should be adopted. A sewage farm, if properly managed, will do something more than pay working expenses, and it is a most satisfactory method, from a sanitary point of view, for the disposal of sewage. A large number of sewage farms exist in various parts of the world, and the results are uniformly satisfactory. There are two methods (which are largely used) of applying sewage to land :—*a*, Broad Surface Irrigation ; *b*, Intermittent Downward Filtration. A third method,

known as Sub-surface Irrigation, is employed to a lesser extent, chiefly on small areas.

Broad surface irrigation consists in distributing sewage over land, so as to water and manure it, and render it capable of producing crops of various kinds. There should be very little surface preparation if the site and the soil are suitable, the sewage being absorbed by the surface soil, and retained until the water is given off by evaporation. The sewage of 150 persons can be disposed of for every acre, but frequently much greater quantities of sewage are disposed of in this way. "Intermittent downward filtration," as described by its author, Mr. Bailey Denton, M. Inst. C.E., "consists not in crowding sewage continuously on porous land, often adopted to get rid of sewage, but of concentrating it at regular intervals on as few acres of land as will absorb and cleanse it without preventing the production of vegetation. It was first applied in 1871 at Merthyr-Tydvill, one acre of land being used for the sewage of 1100 persons. The sewage is distributed by means of ridges and furrows so as to reach the roots of plants laterally through the soil without touching the leaves. The sewage is allowed to run on the land for about six hours at a time, and there are generally four plots, which are used in this way in succession for a period of one year, the other three remaining fallow, so that each plot has a three years' rest." There is no well-defined line between the Irrigation and Filtration methods, the main difference being one of intensity; the intermittent filtration method requires a very porous soil, or thorough surface preparation and under-drainage so as to prevent saturation. It is generally most convenient to combine these methods on the same farm, using the filtration areas as a safety-valve to the farm. Examples of Sewage farms may be seen in Adelaide, Sydney, and Christchurch. In England, sewage farms exist at Birmingham, Croydon, Leamington, Oxford, Bedford, Doncaster, &c. One of the finest sewage farms in the world exists at Genvilliers, and receives a large portion of the sewage of Paris. The whole of the sewage of Berlin is pumped to sewage farms. In America there is a sewage farm at Pulman. The purity of the subsoil waters at the Genvilliers farm is stated by Pasteur to be most satisfactory; there are five lines of drains, which surround the village of Genvilliers, and discharge into the Seine, and the farm produces the finest vegetables and salads which are sold in Paris; the health of the Commune leaves nothing to be

desired. The Berlin farm at Osdorf is controlled and cultivated by the city of Berlin for its own account, and the sales from the farm cover all working expenses, but not the interest on capital.

With regard to the disposal of those organic wastes which are unsuitable for conveyance by means of water, these may be divided into two classes: *a*, nightsoil, offal from slaughter houses, condemned food, diseased animals, &c.; *b*, vegetable wastes, street sweepings, &c., known as garbage. The former may be converted into a poudrette manure, the latter is best disposed of by burning it to a hard clinker.

Farmer's Patent Dessicators have been largely used for nightsoil and the offal of slaughter-houses, which consists of a steam jacketted twin cylinder, provided with steel scrapers or arms attached to shafts; the shafts revolve and carry round the arms, which thoroughly mix and cut up the material; scraping the core of the cylinder, they move the charge backwards and forwards and automatically eject it at the two discharging doors when the process of dessication is complete. The vapours arising from the drying process are drawn off by means of an exhauster fan, and discharged into a surface condenser, or burnt in a furnace. The charge, when drawn, if offal is being treated, consists of a fine brown powder, smelling like cocoa; it is a valuable fertiliser. In the City of Melbourne this system is used to deal with the abattoir refuse, and the results are most satisfactory. Mr. E. W. Cracknell has patented an apparatus for dealing with nightsoil, which consists of a single steam jacketted cylinder, resembling a boiler; a shaft, carrying arms, is made to revolve in this cylinder, cutting up the nightsoil and other materials discharged with it. The gases given off are burnt in a furnace, and the product is sold as manure.

Farmer's apparatus appears to be more suitable for abattoir refuse, while Cracknell's appears to be most suitable for nightsoil.

With regard to the destruction of garbage, various systems have been introduced in England which have for their object the destruction of this kind of refuse, and the combustion of the noxious gases generated in the process; among the most extensively used is that known as Fryer's. In Sydney, Mr. E. W. Cracknell has also designed and constructed a destructor for garbage. Fryer's apparatus consists of a group of furnaces or cells, arranged back to

back, in which the refuse is burnt, and which slope down towards the furnace doors at an inclination of 1 in 3. There are two floors, one on the ground level, the other on a raised platform 15 feet above it. The refuse is taken in carts up an incline of 1 in 14, and deposited alongside the destructor, and is shovelled into a row of hoppers at the head of the cells. The refuse is dried by the heat reflected from the walls of the furnace, and subsequently burnt to a hard clinker, which is ground into a fine sand and used with lime for mortar. The gases and vapours generated pass along a horizontal flue between the rows of cells, and discharge into a high chimney. Between the cells and the chimney a multitubular boiler is arranged, which generates steam by means of the waste heat, which is used to drive the machinery for grinding the clinkers produced in the furnaces or cells. In some of the latter constructions a small muffle furnace, kept at a temperature of 1500 F. is arranged between the cells and the chimney to complete the combustion of the gases generated, and to collect dust and other matters which would otherwise be discharged by the chimney.

Mr. E. W. Cracknell's garbage destructor consists of a circular drying chamber, in which the material is first introduced, which is surrounded by another cylinder forming an annular space, which is filled with water and steam. The cylindrical vessel communicates with a reverberatory furnace arranged immediately under it, into which the dried material is raked, and which is supplied with the gases given off in the drying process. The garbage is burnt upon the hearth of the reverberatory furnace to a hard clinker. The steam generated by the waste heat in the annular space round the drying chamber is proposed to be used in a variety of ways, for driving machinery, &c.

In some of the later forms a second furnace is arranged for intercepting paper, dust, &c., which would otherwise be discharged into the main flue leading to the chimney.

Now, the object aimed at in all Destructors of this class is the continuous destruction of the refuse delivered to them as fast as it is collected, so that the accumulation of all decomposing and offensive matter is avoided. It is also necessary, with a view to prevent the possibility of any offensive smell, or the discharge of any dangerous gases or vapours into the atmosphere, that the gases from the chimney should consist of the completely burnt-out products of com-

bustion. The vapours and gases given off in drying the refuse are not nearly so offensive as those given off in incipient burning before the material gets into the condition of active burning. These vapours and gases in the Fryer's Destructor are supposed to be destroyed in the muffle furnace, but it is clear that this furnace must offer considerable obstruction to the draught. In Cracknell's Destructor they are supposed to be destroyed as soon as they are generated, by means of the high temperature of the reverberatory furnace. I consider Cracknell's Destructor to be much more in accordance with the principles necessary to insure perfect combustion than Fryer's. The success of each will depend upon the quantity of combustible material contained in the refuse. I think it is most desirable to destroy this refuse somewhat in the manner indicated, rather than follow the objectionable practice of depositing the refuse on low-lying land, and endangering the health of the community.

I have endeavoured to explain the various methods by means of which the Sanitary conditions of Cities and Towns may be improved, and thereby rendered much more desirable places for people to live in; and I hope I have succeeded in representing to you the various matters which must be considered before deciding upon any particular system which may be proposed for towns in Australia, Tasmania, and New Zealand.

Section I.

LITERATURE AND FINE ARTS.

Address by the President,

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One question rises naturally to the lips of a man situated as I am, if he be possessed of a sense of the congruities of things, and a sense of incongruities is not far from a definition of humour. *Que diable fait-il dans cette galère?* "The wrong boat?" is the thought that will rise unbidden, or, to paraphrase Molière's famous line, the President of this Section asks himself the question, "What the dickens are you doing in this boat?" Gideon's fleece was moist when all around was dry. Gideon's fleece was dry when all the ground around it was dew-besprent. It may be counted very fortunate that this historical parallel has thus two aspects, so that anyone may choose which he pleases, when I compare "Literature and the Fine Arts," surrounded by Science, to Gideon's Fleece.

Science that studies the cause of things is very fond of talking of evolution and origins. It is interesting to consider and even to speculate (in a philosophical sense) upon the origin of this Section. It can hardly be described as lost in the dim mists of ages, for, as historians tell us that this is only the fourth meeting of the Association, there must be some still living who can remember its inception. Literature and science in the modern acceptation of the latter word have not always been friends. If they be sisters, there is no doubt that literature is the elder sister, and I am bound to add that she has very often played an elder sister's part. She has given advice, often undesired advice; she has not hesitated to snub. Now, in these last ages of the world a great deal of attention has been paid to the younger sister. Equipped with a much finer establishment, constantly demanding and obtaining even better equipment she is beginning to afford the luxury of giving herself airs. It was

more than could be expected of human nature that she should forego an opportunity of turning the tables on the elder sister. "Let me show you a little hospitality," she very civilly said, but she with difficulty repressed a chuckle as she said it, and she swept out a small back room (I is the ninth letter of the alphabet) for her elder sister, and then she put another sister, Art, in with her, without making any kind of inquiry how the two were likely to agree. According to most inquirers this is the origin of Section I. But as a faithful investigator, I am bound to add that another, though less plausible, explanation has been offered, viz.,—that it is based upon the official toast list of public banquets. "The Queen, God Bless Her," "The Governor, God Guide Him," "Army, Navy, and Volunteers," "Clergy of All Denominations," "The Parliament," "The Ministry," "The Guest of the Evening," "Our Financial Interests." So the banqueters pass gaily through the list, when suddenly it occurs to some one that there is such a thing as mind; and just before the toast, the insulting position of which marks banqueting man's estimate of his fairer partner, and just ere the revellers leave the banquet-hall deserted, comes the conglomerate toast, "Literature, Science, and Art." These inquirers maintain that Science never appreciated being thus sandwiched, and is now taking a sly revenge. This theory of the origin does not wholly satisfy me, but it does serve to explain what would otherwise be inexplicable, namely,—the conjunction of Literature and Art. To ordinary minds there is a closer connection between mineralogy and geology, which are in different sections, between geology and biology, than there is between letters and the fine arts. Of course an ingenious mind can discover connecting links: what cannot an ingenious mind discover? And when later on I pass from one subject to the other you shall test my ingenuity in discovering a satisfactory bridge by which to cross.

I thank the men of science who rule this Association for doing me the honour of electing me a President. I am officially bound to be grateful for the hospitality which Science thus shows to literature and the fine arts, but especially at a time when it is proposed that the Section should be ended I have a deeper duty to fulfil. I must speak frankly, and I take for my text the words, "Literature will take care of itself." Do you know who uttered those words? It was one of the strongest of England's Prime Ministers, William Pitt, in the plenitude of his power. Application had been

made to the Treasury for some assistance to Robert Burns, and Pitt, who was lavishing money like water in resistance to France, spending twenty millions in the absolutely useless Walcheren Expedition under the command of his incompetent brother, refused the little subsidy to the poet, using the words that I have quoted. Whether Pitt was right or not in the refusal, they are noble words—not so noble, perhaps, in the mouth of Power refusing to assist, as in the mouth of Literature, putting from her pensions and endowments, places and titles, for fear lest in the days to come public and collective patronage should assume the functions once performed, to literature's serious detriment, by private patronage.

> "And mark what ills the scholar's life assail,
> Toil, envy, want, the garret, and the gaol."

So, in his sonorous English, wrote Dr. Johnson in the first edition of his "Vanity of Human Wishes." But the garret is only a special form of the want which precedes it. A new sting was added to the line in the later form that Dr. Johnson, fresh from his experience with Lord Chesterfield, gave it:—

> "Toil, envy, want, the patron, and the gaol."

Literature having once, and thanks partly to Johnson himself, shaken itself free from the fetters of patronage, will not readily—will never, if wise—put on the old chains re-cast. Of literature the public is the patron—perhaps a day may come when Science can make the same claim. "Literature will take care of itself." "Yes," added Mr. Southey, according to a well-known passage in Carlyle, "it will take care of itself; *and of you, too*, if you do not look to it!" It sounds a somewhat truculent threat on the lips of the blameless Southey. The tone is different from that of a greater poet, expecting an assault upon the city where he dwelt:—

> "He can requite thee, for he knows the charms
> That call fame on such gentle acts as these;
> And he can spread thy name o'er lands and seas
> Whatever clime the sun's bright circle warms."

There is a sense in which a literary man surrounded by the scientific may fairly add, "and of you, too." When men of science press, as they sometimes do, for the extrusion from our educational courses of the humanities (excuse the good old term—it is not so much pedantic as Scotch, and very expressive), then I venture humbly to maintain that

science needs the helping hand of literature. The art of expression, that valuable though not altogether incommunicable gift which we call style, may I commend the pursuit of it to my brethren of the other sections in this Association? A world in which science reigns supreme, where she exercises complete control over education, complete mastery over platform, chair, and pulpit, would run the risk of being a dull world. Folk would perhaps live longer; but would they be happier? A slight sketch of that coming time has been given by a master hand in the Preface to the First Series of *Essays in Criticism.* What is readable will be read, and many books on scientific subjects are simply not readable. The few can study them, and thereout suck they no small advantage; but such books are not read for pleasure. They are without form, if not void. On the other hand, some books of science may be said, in Shakspeare's words, to "give delight and hurt not." It goes without saying that the man of science wants an appreciative audience—wants his influence to be felt. To gain these ends what he learns from literature will help him, and in that sense literature will take care of science too. In this connection it is advisable to point out the importance to the man of science of the faculty of the imagination. Everything in science must be proved. Granted; but the steps of the discoverer were not always made in a logical fashion. The imagination of the man of genius skips steps, jumps difficulties, and then, having reached a truth to which reason did not lead him, he goes back and finds the needed proof. Imagination is also needed to prevent the man of science from being one-sided, to develop other parts of his nature. That is a sad passage towards the end of Darwin's life where he tells us that when he was younger he appreciated music and poetry, Shakspeare and Beethoven; but that as he devoted himself more and more to scientific investigation, he felt himself become a mere machine for the grinding out of scientific facts. We refuse to believe it of Darwin, even on his own statement, but the statement indicates decidedly this danger of one-sidedness.

"Literature will take care of itself." We are told that whilst the Australasian Science Association as a whole prospers, this Section flags and falters, and its failure has even been made a reproach against the literary men of these Colonies. It is no just reproach. Literature is taking care of itself. In the present condition of the public mind and of national education literature is read by the many, and science papers

by comparatively few. Imagine a literary article and a scientific article of the same standard of excellence and consequent importance to the community; the former has a market value, the latter has not. Societies are needed to foster papers of the latter type, and such societies do yeoman service when they receive and print scientific papers, which "caviare to the general" are of the utmost importance to the specialist. Men of science will not, I am sure, feel hurt if I say that science cannot take care of itself. It needs laboratories, apparatus, academies, societies, endowments. But literature can take care of itself; and if the *fiat* be about to issue that Section I. must die, its President can but utter the title of one of Longfellow's most beautiful poems—the poem that the old poet read before his surviving class-mates on the 50th anniversary of their graduation, the title itself, as an American critic remarks, a stroke of genius—"*Morituri salutamus.*" Nor do I say this beseechingly to you, as one might ask that the axe should not descend, but rather, may I be forgiven if I say it jauntily, airily, after the manner of the gentleman mentioned by Herodotus, who danced away his marriage, and to all expostulation made reply, "Hippokleides don't care." For the very truth is that literature is able to make its proud boast that it can and will take care of itself.

Did you ever ask yourself the question—What is literature? Sometimes people talk as if all books were literature, which would then indeed be a most incongruous, agglomerate mass. Many books and much writing have no more right to be called by the attractive, the almost sacred, name of literature than an advertisement, a catalogue, or a directory. Dictionaries may be helps to the literary; they are not literature. Of handbooks and grammars the same may be said. I have essayed gently to explain that many, even most, scientific treatises are not entitled to be included. Many histories and biographies must be ruled outside. We seem to be excluding many books and classes of books of which it may be said that they are books and not books, but the residuum is large. Literature is that class of books in the writing of which attention has been paid to the form and shape—books that have the charm and ornament of style. Such books are poetry, essays, works of fiction, and those books of instruction, history, science, or travels in the production of which the pleasure of the reader, as well as his edification, has been considered. *In Darkest Africa* is not a

contribution to literature. I would rather march through 50 miles of the jungle described in it than read it from cover to cover. The office of literature—I think it is Mr. Birrell who says it—is to please; and I think the same writer quotes Dr. Johnson's remark that a book should either make life happier or teach us to endure it. When Epicurus said pleasure was the *summum bonum* he meant the highest kinds of pleasure, and in the same way it is the highest kind of pleasure that literature aims at. "We needs must love the highest when we see it."

The French term for Literature is prettier than the English. They call it *belles lettres—Les belles lettres et les beaux arts.* There you have the connection between the two divisions of this incongruous Section. The element of the beautiful is present in both of them, and is an ideal at which both Literature and Art must aim. And now see how difficult it is to treat such things as scientific questions are treated. Analyse the rose and you lose its perfume. After dissection the beautiful will not remain beautiful. We all desire that good literature and good pictures should be produced in these Colonies. What avails it that we read papers on poetry? It is the old fallacy of an art of poetry. Rules will not produce poetry. And if a critic wishes to draw attention to what is good, other modes are open to him. Young Mr. O'Hara, of Melbourne, has lately produced a pleasant little volume of poems. Would it help him, or would it help forward the poetic muse, if there were a discussion of his poems in this Section, and one praised and another blamed them? The test of poetry is the highest enjoyment; and disputes as to matters of taste are proverbially unprofitable.

May one not say something very similar with respect to pictures? A controversy such as lately took place in Melbourne over Mr. Waterhouse's Sirens is interesting as far as it shows that public attention is been given to pictures and to Art questions, and as it shows how wide is the divergence even among educated tastes. We can only hope it forwards Art. Why don't the public galleries buy the works of local artists? Could you not imagine a paper on that subject—the jealousy, the prejudice, the ignorance that would be imputed to the committees charged with the selection of pictures? The standard of excellence is so manifestly and so rapidly rising in our leading local schools of Art that it is less cruel to say now that when the pictures

are good enough they will be bought. A mistake may be made here and there. Please the public and the caterers for the public will buy. Novices in Literature often bother their friends for an introduction to an editor. It is quite unnecessary. The editor is anxious to procure the best wares for his magazine or paper—is looking out for them. Let the novice send what is decidedly good, and it will suit the editor, though possibly, if the article is in a bad handwriting, if it has a long exordium, it will go into the waste-paper basket. What is good in writing, in painting, or in sculpture will be bought.

It might be well to mention sundry ways in which this Section might render good service. The first that I heard proposed was at Sydney three years ago by Mr. Bernard Wise, formerly Attorney-General. It was the preparation of a complete bibliography of Australasia. That is a handbook which is wanted, which would be within compass, and once done might easily be kept up. It could hardly be compiled by private enterprise, for its value depending on thoroughness, it would take much labour and need much co-operation, and it is very questionable whether it would pay. Perhaps such a work might best be carried out by fellow-work on the part of the Librarians of the great Public Libraries of Australia. It ought to contain early references to Australia from various sources; ought to contain parts of books as well as complete books, the many accounts of travel, the books on Australasia as a whole, the books that describe separate Colonies. There should be a tabulation of Magazine Literature, that part of *Poole's Index* magnified. There should be a calendar of Blue-books. There should even be a calendar of what is known as light literature, the fiction that deals with Australia, for the world no longer even professes to despise novels. Though the list of these would be long the task would not be difficult, for it is only of late years that the novelist has turned his eyes towards our shores and paid us such overwhelming attention.

Another matter to which the Section might draw attention is the study of the linguistics of our part of the world. After the Melbourne meeting two years ago I remember reading an indignant letter in a newspaper denouncing this Section, but especially the literary professors in the Australian Universities, for not interpreting Literature and Fine Art as the study of the Aboriginal languages. My withers were unwrung, for I was in England at the time of the meeting. It seems generally allowed that this Section is beyond all

others elastic, and though I may seem to trespass on the province of my brother President, who looks after Anthropology, I should like to say a word on the study of the disappearing languages of this end of the world. A few years since I was talking to the editor of a well-known London literary paper, and we were discussing the thrilling subject of land tenure. "How the future will curse the Australian Colonies for neglecting their opportunities!" he said. "You had a clear field, a *tabula rasa*, and you have reproduced the old world. You ought to have tried experiments for our behoof, for the world's good to have tested theories; but you have been content to follow beaten tracks." To this kind suggestion there are obvious answers, for neither a generation nor a colony cares to risk a sacrifice of itself, its happiness, its future, in order that the world may enjoy the advantage of an object-lesson on a magnificent scale. But among the vanishing opportunities, soon to be reckoned lost, must be counted the scientific study of the habits and the languages of the Aborigines. It is the story of the Sibylline books over again. Once such study was comparatively easy; there were numbers of natives brought into frequent contact with British settlers. But for many reasons scientific advantage was not, perhaps could not be, taken of this constant intercourse. Settlers were busy, inquirers were not trained. Meeting as we do in a Colony where the last aboriginal is dead, considering that the last estimate of the number of aboriginals in Victoria is 731, can anyone maintain that there is anything like the same opportunity now? We are reminded of the words of Bacon:—"Occasion, as it is in the common verse, turneth a bald noddle after she hath presented her locks in front, and no hold taken; or, at least, turneth the handle of the bottle first to be received, and after the belly, which is hard to clasp." But a scientific study of the native languages of Australia and of the islands of the Southern Seas is yet possible. In a few years it will be less possible; in a few years more the opportunity will have been lost. Research of the kind would need endowment, but not a large sum. Probably even £500 a year for five years would lead to valuable results, which would otherwise be lost to the world, if only the investigation were carried out in a scientific, systematic manner, the inquirers trained for the work, the lines of work defined and regulated. Our Universities might well train inquirers if only the money were forthcoming. Nine years ago there was published in

The Argus a letter from Professor Sayce, of Oxford, very much to the effect of what I have been repeating. It must be borne in mind that Sibylla will not for ever continue her offer.

It is a question whether a great dictionary of a language is better compiled by a society or by an individual. In France and in Italy such dictionaries have been produced by the French Academy and the Academy *della Crusca;* yet Littré's French Dictionary, the work of a private person, is thought better than that of the Academy. In England there have been sighs for an academy from men as great as Dryden, and the sighing has not altogether died away; but the work of dictionary-making was left to private individuals until about a generation ago, when preparations for a new English dictionary on a large scale were taken in hand by the Philological Society. This noble work, now proceeding, is a good specimen of co-operation of individual labourers combined with public bodies. The Philological Society began it; the University of Oxford is at charge of printing it; but the control of the literary work is entirely in the hands of Dr. Murray, who has now divided the band of scholars working under him, arranging the materials in his scriptorium at Oxford, and half of the workers are now under the captainship of Mr. Henry Bradley. Dr. Murray has invited assistance from our end of the world for the words and phrases peculiar to Australasia. A body like this Section, composed of men from different parts of scattered colonies, might render valuable help in organising this work of collecting authorities for our various peculiar words and usages. Twenty or thirty men and women, each undertaking to read certain books with the dictionary in mind, and to note what is peculiar in a prescribed fashion, could accomplish all that is needed. Something has been done in Melbourne, but the Colonies have different words and uses of words, and this work is of a kind which might well extend beyond the bounds of a single city. At first it may seem as if our words were few, as if in the hundred years of Australian life few special usages have arisen; but a man with a philological turn of mind, who notes what he hears, will soon find the list grow. This is true not only of slang, though even slang, being the speech of the people, is not undeserving of some scientific study. Some philologers speak, not very satisfactorily, of being "at the fountains of language." We can all of us testify to the birth of some words within our

own memory, but the origin of these, if not noted, will in time be lost. There are many other words which the strictest cannot condemn as slang; words, for instance, which have come into the language from the Aborigines, such as corroboree, waddy, and names of animals, shrubs, and flowers. It might even be possible, with sufficient co-operation, to produce an Australian dictionary on the same lines as the *New English Dictionary* by way of supplement. Of course we are all horribly busy, but organisation might make the labour light, whilst for many it would from its very nature prove a pleasant task.

To turn this Section into a meeting for the discussion of educational questions has occurred to some as a happy expedient. Having been engaged in the service of education for a quarter of a century, I might be expected to welcome this diversion. No doubt it may be of great public value to have such an intercolonial debate on educational matters, nor do I wish to say aught against it but this: Education is not Literature, nor is it Fine Art. The provinces of education and of the section overlap, and no one would be very strict about drawing a line of demarcation. On education I will permit myself a few words, really few, for education is a very wide subject, and fruitful withal, and it would be quite easy to go off at score. Even if I confined myself to recent educational developments, there would be plenty to say. I might comment on the establishment of the Victorian Institute of Schoolmasters as a sign that those who are engaged in secondary education have at length recognised that it is better to pull together than in diverse directions; and I might point out that the authorities of the Institute are very anxious to establish intercolonial relations. I might draw the attention of the Science Association to the Science Scholarships that have been established by the Commissioners for the London Exhibition of 1851. Of all Exhibitions, the first, the Crystal Palace, was the most successful, and its Commissioners are still handling a surplus. Happy men! These Science Scholarships, or some of them, are offered to students of Colonial Universities to enable them to continue science study either at their own universities or, if possible, elsewhere. I might also claim some credit for Melbourne University for the success of the scheme of extension lectures, but though that success has already been very great, the scheme is so new that we cannot say more than that it is full of hope, and that we have fair reason to look for permanence.

But the most obvious educational topic is the establishment within the year of a new university in this very city where we are meeting. On behalf of one of the sister colonial universities, I offer the right hand of fellowship to our new sister, and wish her every success. A new university, of course, is small, but universities like Sydney and Melbourne, which are no longer small, began not much more than a generation ago with beginnings that were even smaller. A journey through the United States six and twenty months ago, on which I saw something of no fewer than ten American universities of various shapes and sizes, and during which I read a good deal about the universities in the States, makes me desirous of giving one warning to the Australian Colonies and to Australian statesmen. It is not wise to multiply universities. In this matter the law of supply and demand cannot be trusted, if it ever can be in the matter of education; and the Legislatures should be very careful not to permit the promiscuous conferring of degrees. Let them increase teaching facilities as much as generosity may make possible, but not lower the standard, as at least in higher education competition does. In America there are five or six degree-giving universities to every million inhabitants, and a degree by itself has no value.

If Australia were one country, as it ought to be, two universities would probably be quite enough, or, better still, even one, but it would need to be arranged somewhat on the pattern of the University of New Zealand, with teaching bodies in different places, but one uniform standard of examination for each degree. This would lead to emulation between the different teaching colleges, and would surely have happy results. Unfortunately, Australia is not one, and at present it looks as if, in spite of the wishes of the people, our absurd divisions were likely to continue. Yet it is worth consideration whether the universities might not agree upon a common standard, and arrange that the courses in the universities of the different Colonies should be parallel and homogeneous. Educated men should be the first to show that the day of discord is over, and to welcome the arrival of unity and co-operation. One last word upon education, which I have felt I should not treat as the main object of my address, but rather as a side-subject, and it is this:—Examinations are necessary, or, if the phrase be preferred, are necessary evils, but neither in universities nor in schools should they

ever be allowed to take first place. Teaching is much more important than the testing of the teaching. I am opposed to the multiplication of examinations, and would favour any proposal not to make them easier but to make them simpler.

I now propose, as a wordmonger interested in the history of words, to consider a word which you will often hear in the next few days. It seems to me that the present use of the word Science, as, for instance, in the title of this Association, is quite modern. I asked my friend Professor Laurie for an accepted definition of Science, and he gave me the following as that which he is in the habit of imparting to the students attending his lectures :—"A science may be defined as a body of kindred truths, systematically arranged, marked out from other departments of knowledge by some broad definition of subject-matter and with a view to facility of study and communication." This is admirable. No doubt in this sense Aristotle uses the word ἐπιστήμη; Cicero, the word *scientia* with defining adjuncts; Aquinas, the word *scientia* by itself; Pascal, the word "science" in French. If philosophy or if logic be defined as *scientia scientiarum*, and both have been so defined, *scientia* is used in that sense. But the definition is that of a science, not of Science spelt with the capital letter, and almost personified. The word occurs frequently enough in the writings of the last century, but not in its modern sense. Let us begin with Gray, who would not only have made an admirable President of this Section, but was qualified, if we can compare one time with another, to be President of several other Sections. After his death, his friend Temple wrote that he "was perhaps the most learned man in Europe. He knew every branch of history, both natural and civil;" and the branches of natural history that Gray knew so well are defined as botany, zoology, and entomology. Gray, therefore, who knew the sciences, would have used the word science in its modern meaning, had that then been attached to it. In the epitaph that closes the "Elegy in a Country Churchyard" occurs the line—

> "Fair science frowned not on his humble birth."

To a modern reader that naturally conveys a modern idea, but that is the sort of mistake we are always making when a word has slightly changed its meaning. Gray only meant knowledge or learning in general. He might have substituted knowledge for science in the epitaph, or science for knowledge in the earlier lines—

"But knowledge to their eyes her ample page
Rich with the spoils of time did ne'er unroll;
Chill penury repressed their noble rage,
And froze the genial current of the soul."

In the Ode for Music at the installation of the Chancellor of the University of Cambridge, Gray speaks of "bright-eyed science." If this ode were revived at the next installation, when the present Duke of Devonshire succeeds his father, (name "dear to science, dear to art") the word would bear a wholly different meaning from what it had when Gray used it. But there is a still better instance in the "Ode on a Distant Prospect of Eton College"—

"Ye distant spires, ye antique towers,
That crown the wat'ry glade,
Where grateful Science still [*i.e.*, always] adores
Her Henry's holy shade."

Now, one need be very slightly versed in the history of English education to be well aware that, whatever Eton may teach now, not a single scrap of what we technically call a scientific education was imparted there in August, 1742. In the middle of last century, in the reign of Dr. Johnson, nouns with a Latin origin had the preference over words of English origin. Let us test the use of science by Johnson himself. Four years earlier than the "Ode to Eton," Johnson in his "London" makes Thales indignant eye the town, and then burst forth into denunciation of London, in imitation of Juvenal's attack on Rome—

"Since worth, he cries, in these degenerate days
[How often have we heard that since!]
Wants e'en the cheap reward of empty praise;
In those cursed walls devote to vice and gain,
Since unrewarded science toils in vain."

In this remark neither Thales nor Johnson was thinking of geology or entomology. Possibly they would not have objected if such studies had been unrewarded. From an amusing note in Boswell we learn what Johnson understood by a book of science. "We had tea in the afternoon," says Boswell, "and our landlord's daughter, a modest, civil girl, very neatly dressed, made it for us. * * * Dr. Johnson made her a present of a book which he had bought at Inverness." To this *more suo* Boswell adds a note upon the book. "This book has given rise to much inquiry, which has ended in ludicrous surprise. Several ladies, wishing to learn the kind of reading which the great and good Dr. Johnson esteemed most fit for a young woman,

desired to know what book he had selected for this Highland nymph. 'They never adverted,' said he, 'that I had no choice in the matter. I have said that I presented her with a book, which I happened to have about me." And what was this book? My readers, prepare your features for merriment. It was Cocker's Arithmetic! Wherever this was mentioned there was a loud laugh, at which Dr. Johnson, when present, used sometimes to be a little angry. One day when we were dining at General Oglethorpe's, where we had many a valuable day, I ventured to interrogate him—" But, Sir, is it not somewhat singular that you should happen to have Cocker's Arithmetic about you on your journey? What made you buy such a book at Inverness?" He gave me a very sufficient answer. "Why, Sir, if you are to have but one book with you upon a journey, let it be a book of science. When you have read through a book of entertainment you know it, and it can do no more for you; but a book of science is inexhaustible." Cocker, a book of science! How far away is that journey to the Hebrides! Can you imagine Mr. Matthew Arnold or even Mr. Carlyle presenting his landlord's daughter, except in a spirit of banter, with a copy of Barnard Smith or Colenso? If we carry our researches back earlier than the eighteenth century, we find that Chaucer uses the word science in the general sense of knowledge, so does the author of *Piers the Plowman;* Shakspeare speaks of music and mathematics as sciences but science in the singular is with him equivalent to knowledge. Milton in his poetry uses science once. Addressing the Tree of Knowledge, the Tempter says:—

> " O sacred, wise, and wisdom-giving plant!
> Mother of science!"
>
> —(P.L., ix., 680.)

Milton also uses an adjective, "sciential," which has not lived. The strangest use of the word science, in its old sense, is in the translation of the Bible—"avoiding profane and vain babblings and oppositions of science, falsely so-called." (1 Tim., vi., 21.) Here the Greek word is γνῶσις, knowledge, and it is used by St. Paul with especial reference to the Gnostic heresies, beginning to be rampant. How many sermons have been preached on that text in the days when the opposition, or supposed opposition, between religion and science was fiercely accentuated! Now there seems to be a truce in the fighting, and many of the soldiers of the two forces fraternise, as Mr. Gleig tells us French and

English soldiers did in the weary days of the Peninsular War. Nothing is more certain than that neither the writer of that verse nor the translators of it had the least conception of collective science, whether rightly or wrongly so-called.

Sixty years ago men spoke of the natural sciences and of this or that science, but they had hardly risen to the conception of science as a body of correlated sciences. Sir Humphrey Davy, who was chiefly a chemist, preferred to call himself a natural philosopher. In many universities physics is still quaintly called natural philosophy. Comte's *Philosophie Positive* is scientific. In Germany the word philosophy is still used in that sense. Germans speak of *Natur-Wissenschaften*, but not of *Wissenschaft* as a generic term to include them all, to the exclusion of other branches of knowledge. A man who at a German university has made a special study of the sciences becomes doctor of philosophy. Many of the English universities have a science degree, but Oxford makes natural science one of the courses for the Arts degree, refusing in any way to separate the scientific training, lest it seem to be divorced from the ordinary curriculum of a liberal education. I am unable exactly to fix the date at which the modern collective use of the word science sprang up; but I fancy a close study of Whewell's *History of the Inductive Sciences* might reveal the genesis of the use, and it is Whewell, I believe, whom we have to thank for the use of the hateful form "scientist."

And here I must close. Please take my Address for what you find it worth, forgiving the author for its deficiencies, partly because he intends well, and partly because it is the very first time he has ever been President of Section I., and it is probable also that he never will be again. If I have not always respected the dignity of the position—if I have sometimes been airy and, as some would say, flippant—I have tried to interest and amuse you; I have remembered what a quantity of improving matter you will hear in the next few days; I have been anxious to assert the independence of letters, and also to prove that Gideon's Fleece need not of necessity be dry.

Section J.

ENGINEERING AND ARCHITECTURE.

ADDRESS BY THE PRESIDENT,

C. NAPIER BELL, C.E.

In fulfilling my duty to one Section, by giving an address on Civil Engineering and Architecture, I feel that a subject of such wide extension, embracing a number of separate branches, can only be touched very superficially within the time at my disposal.

It is usual in an address of this nature to give a sketch of the progress of engineering works and science throughout the world up to date; this, however, is a big job, and, as the main facts of engineering progress are well known to the world at large, I must beware of wearying the meeting with familiar facts. I must therefore pick my way through the wilderness of beaten tracks, gathering a handful of notes by the way, and leave to our members to exhibit the jewels of original research that each has unearthed in his own particular path.

As I am not an architect, I may be taking too much upon myself in saying anything about this art, unless it be allowed that Architecture and Civil Engineering overlap each other's boundaries in so many points that he who practises one will continually find occasions when he requires to know something of the other.

Now, architecture differs from engineering by the circumstance that, in addition to the mechanics of mere construction, it has a large part in "art" considered as combining the beautiful and æsthetic, the sense of harmony and style with construction. Architecture has the advantage of engineering in being the more ancient profession, and in the olden times the two were twin sister arts; it is only recently that, with much hesitation, the stern exigencies of the times compelled them to part company.

Architecture is eminently conservative, long suffering, and slow to changes; the very nature of its existence, the hold it has on the admiration, veneration, and love of the beautiful in men's minds, requires that there shall be no hasty changes, no crude novelties in this stately and venerable art; accordingly we find a stability in its designs, a slowness in its progress, which is altogether out of place in engineering. The most admired and approved architectural designs are still those of the Ancients, or some modification of them, and even in our days it appears hopeless to try to dispense with the old Greek, Gothic, or Italian styles.

> "The force of nature can no further go,
> To make a third she joins the former two."

One must not, therefore, reproach architecture with failing to produce novelties in stone or brick; whenever architects had a new material placed in their hands they were not long in showing what they could do,—the marvellously beautiful and novel styles in iron and glass do great credit to the architects of our day, and prove that we have still a share of that originality, delicacy of perception, and love of the beautiful which animated those who brought the ancient styles to their greatest perfection.

One of the first works in this new material was the Crystal Palace, erected in London in 1851. Since then the new style has been elaborated, and many admirable buildings have been erected for railway stations, markets, summer palaces, and hot-house buildings. Styles of architecture usually take centuries to bring to the state of perfection at which they culminate, and any variation after that shows decay instead of progress. The new style of iron architecture in buildings, towers, bridges, and even in naval architecture, is the growth of the last forty years, and no one can say when it will culminate.

Among the new materials which architecture has had offered to it, concrete is the most remarkable, as being the finest artificial stone that has been invented. Architects have, however, shown no fondness for it, either used in mass or in blocks; they seem to think, as an eminent architect once said to me, "Its texture is hideous and its newness offensive," and I agree with him so far as to say that I have not met with any building in concrete that was pleasing. It is to be hoped that these objections will be got over, for concrete is an admirable material, combining a certain amount of tensile strength with great crushing resistance. For domes and

circular roofs it is very suitable, and its durability is one of its best qualities; it has the disadvantage of being pervious to wet, but this defect may possibly be cured by some chemical wash. Good concrete may be moulded into any shape, or cast into figures or statues, and it is apparently as durable as the best limestone; but the facility and cheapness with which ornamentation may be impressed on it depreciates it in our estimation, just as printed calico is despised in comparison with woven patterns.

Perhaps I am biassed in favour of concrete, because in New Zealand shingle and sand is so plentiful, and sound stone so scarce, that there is always an inclination to use concrete, but in any country where good stone is scarce great building blocks of concrete may be made of almost any rubbly stone broken up, and the cost is generally cheaper than cut and dressed stone. When care is taken to sift and sort the material for concrete, it may be moulded into every possible shape, giving sharp angles and an admirable texture, the durability of which is certain, while that of many stones is never to be relied on. In engineering works concrete has made quite a revolution, and although engineers of the old school were slow to take advantage of it, its merits are now fully recognised. In docks and harbour work, structures are successfully carried out which would have been almost impossible in any other material; the violence and uncertainties of the sea are overcome by the use of great concrete blocks; shifting foundations are rendered secure by grouting beds of rubble with cement mortar at any depth below water; sewers are moulded under water on beds of quicksand, which it would be impossible to pump dry without bringing down the streets and buildings near them. In fact, the use of concrete has dispelled some of the greatest risks and difficulties to which engineering works are liable.

In spite of many objections to its use, in which prejudice has a considerable share, architects should devote more attention to concrete than they have hitherto done, the result of which may possibly be a new architectural style, claiming the admiration of future generations.

When engineering separated itself from architecture it looked forward to an undivided empire over its constructive department, but the same restless spirit of progress has rent it into a heptarchy of smaller states, each soliciting the undivided patronage of the public. Thus we have civil, mechanical, and military engineering; these are subdivided

into hydraulic, mining, electrical engineering, land and engineering surveying, and every year we may look for some new secession from the parent state, so that an unfortunate, lad who may contemplate becoming an engineer is at his wit's end to choose from this Pandora's Box all the gifts in which will be a weariness of the flesh to him.

All these petty kingdoms in the great empire of engineering are distinguished by energy, originality, and progress. There is now no worshipping old models, no drowsy resting upon the old authorities; novel and startling designs and projects burst upon an astonished world from time to time; many of the arts and sciences assist and contribute to engineering, and are assisted by it in turn, each serving as a stepping-stone to the other, until there would appear to be no end to the progress and improvements which every branch of engineering is undergoing. In the different branches into which engineering is now separated, the special knowledge required is so extensive and complicated that no human brain can master more than a part of it; thus the various branches are taken up by those who devote special study to one or other. In this respect mechanical engineering requires such an intimate knowledge of constructive details, of the laws of motion in its most complicated forms, and of the physical properties of matter of every kind, that it was at once evident that it must stand by itself as an entirely different profession.

A man who could lay out extensive railway, canal, or harbour works could not possibly design the machinery of great marine engines, locomotives, or factory mills, and do justice to all.

But in the progress of engineering as a whole, mechanical engineering must be allowed the greater merit. It is to the perfection of tools, implements, and machinery that we owe the possibility of the great engineering works of the present day.

In the old days the want of our modern tools and machinery stood in the way of the use of iron, except as fastenings to wood or stone; but wood is quite unsuitable for large structures, and stone is too unwieldy for many essential uses. The discovery of the means of making up iron into large masses, and every required shape, at once extended engineering possibilities in all directions. The knowledge of methods for making steel cheaply in great quantity still further extended the range of engineering achievements, which is only checked for want of a material harder and stronger than steel. Chemists have been throwing

out hints that in some alloys we shall have this want supplied, with which engineers will not be slow in building up new triumphs of construction.

Engineering does not confine itself to structures in the modern materials of iron and steel; it still works upon the old materials with new and greatly improved methods. The great works of the ancients cannot compare with those of our days, either in magnitude or excellence of design, and this result we owe not so much to the wealth and greater population of modern times, but to our perfection of tools and appliances, our intimate knowledge of structural design, of the cost of work in all details, of the time in which it can be done, to our knowledge of the most suitable material to use in different parts, and our experience and inventiveness in dealing with every difficulty as it arises. These faculties enable us to direct the forces we bring to bear on our works with almost unerring precision; all labour is distributed and directed with the clearest knowledge of the best results to be obtained by the least expenditure of power; little or no labour is wasted, and it might not be an exaggeration to say that we do the same work now with one quarter of the labour that was necessary in the old days.

Although many sciences have helped to equip engineering with its present store of resources, it may be allowed to take credit for the use it has made of them, and when we consider what it has done in modern times one cannot fail to be struck with wonder and admiration. Engineering has almost transformed the earth. It has made the whole world neighbours; the most distant regions are brought within easy reach of each other; it has enabled millions of human beings to live and thrive in places that were inaccessible wildernesses. Small countries like Great Britain are enabled to support a population which would have been impossible were it not for the shipping docks and railways, and the steam machinery which does more work than millions of men and horses. Engineering has taken from travelling all of its toil and most of its danger; journeys across continents and round the world are done for pure holiday pleasure; food and productions of every kind are conveyed in vast quantities across continents and over the sea with a speed and cheapness which is perfectly marvellous; nations mingle together and get rid of their prejudices; even "Afric's sunny fountains and India's coral strand" behold with wonder and delight crowds of Cook's tourists disporting in their midst.

The patience of this meeting will not permit of my wandering into the vast domain of engineering, which is more or less familiar to all of us in its most salient features, and our present occasion is more concerned with what has been done in these colonies, affording a striking example of the influence of engineering on the conditions of life in new countries.

Not many years passed after the establishment of these colonies before engineers were busy in introducing all the appliances of the most highly civilised countries, and now these thinly peopled countries are nearly as well provided with public buildings, roads, bridges, railways, docks, harbours, waterworks, telegraphs, and other paraphernalia of civilisation as any part of Europe or America.

At first there were many persons who thought these public works were premature, and feared that the colonies would be crushed under the burden of the expenditure. Experience has justified the wisdom of spending great sums of money in opening up and improving the country by public works; it is now evident that they are more than worth what they cost, and the importance of these colonies, measured by the enormous trade carried on, is chiefly due to engineering works which enable the people to spread their industry over extensive areas, and yet be within easy communication with the sea ports and the different centres of population. New Zealand is a notable instance of the advantages derived from public works, which at first were strenuously opposed as being unnecessary and ruinous,—the population of about 630,000 export produce to the value of ten millions sterling—more than £15 per head. I know of no country which exceeds this, yet I am convinced that were it not for her public works the present population would not be able to export one quarter of the actual amount.

It is to be hoped that engineering will in the future maintain the prominent position it has held until now, and in a young and vigorously growing community this may be confidently expected. We have, however, no analogy to guide us from the career of former colonies which, as may be observed from history, had no young life resembling that of these colonies, which have enjoyed the advantages of the abundant resources of a new country, together with all the appliances invented for the use of densely peopled countries, and unlimited supplies of capital from the savings of other people. Without capital the tree of engineering withers and

dies. But the colonies will soon learn to make capital of their own; the savings of an active intelligent people devoted not to wars, but to productive industry, will increase from year to year, and a large proportion will always be devoted to public works, the necessity for which grows with the population.

Hitherto the most pressing need in the colonies has been for roads, bridges, railways, and harbour works, and we are already well provided with all these; for although the length of railways bears a small proportion to the areas of the different colonies, it bears a large ratio to the number of inhabitants. Thus the number of people per mile of railway is:—In Victoria, 518; in New South Wales, 521; in Tasmania, 330; in New Zealand, 360; in Queensland, 210; in South Australia, 220; in West Australia, 92. In Canada it is 400; in the United States, 400; and in Great Britain, 1800.

The colonies are also fairly well provided with harbours and docks, and in New Zealand some think we have overdone this class of work. Roads and bridges we have in great abundance, and the extension of these means of communication must go hand in hand with the growth of population.

We have not yet tried our hand on canal works, as, except under special circumstances, railways have totally superseded the use of canals.

In the future one may look forward to the canalisation of the long and sluggish rivers of Central Australia, which may be combined with great canals for irrigation and the carriage of produce.

As the population increases other engineering works become indispensable, and among them sewerage and sanitary works, which are often the last to be thought of, can no longer be neglected. In Australia it is to be hoped that engineers will devote their best attention to this important branch of public works, because in that dry climate sewerage and waterworks have a double significance,—first, to cleanse the towns; second, to save the sewage to irrigate the land.

It is usually taken for granted that sewers have fulfilled their functions when they convey away from a town all the filth that can be carried by water, and it must be remembered that the liquid filth is nearly ninety per cent. of all the impurities that originate in a town. But if these impurities are not applied to the land there is a waste of manure, which no country can long afford to lose.

On this subject Australian sanitary engineers should pause

before they copy the practice of Europe, which, enjoying an abundant rainfall, has never felt the necessity for irrigation, and has had abundant stores of fossil manure to draw upon. The fact that it often does not pay to put sewage on the land is not sufficient justification for wasting it, and the public, as well as engineers, should strain a point in urging that the sewage of towns be applied to irrigate land wherever possible.

The productiveness of land irrigated with sewage is a remarkable fact, and the double purpose is served of cleansing the cities and feeding the people. Many persons recoil from the idea of being fed by the produce of sewage filth, but their prejudice is groundless, or is founded on a misapprehension of the functions of growth in plants, and a wrong interpretation of the conditions under which plant life exists on the earth. No plant can continue long to grow unless the matter which it has produced be given back to it, and it is an essential condition of the life of plants that the dead waste matter of plants and animals be restored to the soil. Sewage irrigation does this in a fairly efficient manner, and it is essentially suitable to a dry hot climate like Australia.

Sewage irrigation is, however, not so important as water irrigation, and I foresee for engineers a noble task in providing irrigation for Australia, a task second in importance to none of the engineering works hitherto undertaken. Irrigation will feed and nourish the people and beautify the land; in many districts it will transform the country, changing its aspect from that of Arabian deserts to that of the Vegas of Malaga and Seville in the days of the Saracens; it will make the country life of the peasant and farmer pleasant, healthy, and profitable, which, under present conditions, is scarcely possible; it will cover the country with villages surrounded with groves, orchards, and gardens, and turn the burning heat on a naked land into the perfumed and luxurious warmth that delights the traveller in the West India Islands. This must not be taken as an idle dream; irrigation has done it for many countries and will do it for Australia if the people have confidence in it and in her engineers. Irrigation is new to us, but the art is as old as the hills, and I hope the rising school of engineers in these colonies may yet reproduce some of the marvels of the ancients; they must not slavishly imitate the humble works of modern times, but acknowledge frankly that the old irrigators were our masters in this branch of engineering.

At the risk of wearying the patience of this meeting, I would like to recall to notice one or two instances of what has been done in irrigation, which may serve as ideals at which Australian engineers should aim.

The alluvial country which surrounds the rivers Tigris and Euphrates is, at the present time, a parched and dry desert, on which wandering Bedouins find a scanty pasture for camels and horses, cultivating a little barley and millet close to the rivers by means of water raised in buckets; yet this country was the home of one of the oldest and grandest nations the world has ever seen, with the great city of Babylon for its capital, the circumference of whose walls was greater than that of modern Paris outside the fortifications. This great city and nation depended entirely on irrigation.

As the two rivers yield a very scanty supply in summer, but discharge a vast body of water in floods, the Babylonians built a reservoir to retain the water of floods to irrigate the land when the rivers were low. The size of this reservoir is so enormous that we may well doubt whether, as related by Herodotus, it was entirely artificial; it would contain 3200 millions of cubic yards of water, and if it could be completely emptied, which must be assumed if it served the purpose intended of controlling the floods as well as storing them, it would irrigate nearly two million acres one foot deep in water.

A large part of Australia is very similarly situated to the Mesopotamia of the East; it has great plains of good soil, but arid for the want of water; it has one or two large rivers usually carrying a scanty supply, but when flooded a vast quantity of water, charged with fertilising silt, rushes to waste in the sea.

Australia has arid hills as well as plains, and the time must come when these will also be required for cultivation. Here the rising generation of engineers would do well to consider the stupendous irrigation works of the ancient Peruvians, the magnitude and difficulty of which excite wonder and admiration in every one who sees their ruined remains. Some of their aqueducts, or water-races, as we call them, were many hundred miles long, carried through tunnels in the hills, over deep ravines, and along the face of precipices 400 feet or so above the foot.

Peru is now desolate and poverty stricken, but in the time of the Incas the whole country seems to have been under cultivation almost to the tops of the Andes, the ruins of towns

and villages, land terraced for cultivation, and old water-races, are so numerous that a traveller told me he could scarcely believe the evidence of his eyes, and it seemed as if he were in a dream.

For a long time to come agriculture and mining must be the staple industries of these Colonies. New countries, with their natural resources untouched, require that all available industry should be devoted to extracting these resources and exchanging them freely for the manufactures of more densely crowded communities. In mineral wealth these Colonies are richly endowed by nature, and the aid of engineering will be called upon to enable this wealth to be developed. Civil, mechanical, and mining engineers will here find a wide field for their respective careers, and when the feverish and spasmodic gold digging has subsided we may look for a settled industry which will maintain a large mining community in a happy and prosperous condition.

The mining industry requires for its assistance a great variety of engineering work, such as roads, waterworks, and machinery, and the great distances inland where minerals are frequently found will require extensive works to bring the products to the towns and coasts. Thus we may look to mining for a continual extension of the engineering "sphere of influence."

The mining engineer, as commonly known in these Colonies, has not yet taken the prominent position which he ought to occupy, both for the good of the public and the profession. A well-trained mining engineer, as understood in England, but especially in Germany, has to acquire an amount of special, practical, and theoretical knowledge which, applied to the working of mining property, amply repays the increased cost of his well-trained services, and may often be the means of turning a ruinous investment into a highly profitable one. This class of thoroughly efficient mining managers and engineers is of especial importance in these Colonies, where, from the high rate of wages, the margin of profit is apt to be very narrow.

In the Charter of the Institution of Civil Engineers, one of the definitions given as constituting the profession is stated to be "The art of directing the great sources of power in nature for the use and convenience of man"; it is essential, therefore, that engineers thoroughly appreciate the value and nature of these sources of power. Electricity has recently taken the world by surprise in the many wonders it has

disclosed, and a vast amount of learning and mechanical ingenuity has been devoted to it. For many purposes, such as lighting, chemical reactions, concentration of intense heat on small surfaces, small motive powers, and telegraphic communication, it has a world of its own. In my opinion many people expect too much of it, their mistake appearing to be in their conceiving electricity to be a new power. This conception is evidently wrong, for electricity has its existence only in the old powers of heat and gravity—the steam engine or the waterfall. Electricity has its own sources of waste and loss of efficiency, which are always in addition to those of the machinery employed to generate it. For this reason electricity is seldom profitably used directly in substitution of steam or water power.

For conveying power to long distances it has certain advantages which, according to the circumstances of the case, may or may not be counterbalanced by the erection of a steam engine on the spot.

It is impossible to foresee what the future has in store for electricity as a means of utilising the power derived from coal or other forces of nature, therefore we cannot tell what part engineering will take in its use and development. My own impression is that as long as coal lasts it will always be found the best and handiest source of power, as in no known form is power contained in so small a compass. Thus, to compare the power of coal to that of falling water, which seems to be the next best source of power:—In engines burning $2\frac{1}{2}$ pounds of coal per horse-power per hour, the mechanical effect of one pound of coal is equal to that of 40 tons of water falling 12 feet, and some engines burn less than $2\frac{1}{2}$ pounds per horse-power per hour; yet this effect, developed in the best engines, is only about one-eighth of the total energy given out by coal during its combustion.

Now, although in many cases water may be had for nothing, yet for large powers the quantity of water, or the height of fall required is so great, and the necessary appliances so costly, that people prefer to use steam whenever coal is to be had at a reasonable cost. For heating and for portable power, such as steamships require, I do not think we have any evidence that coal can ever be dispensed with, and much less that electricity can take its place. Notwithstanding modern discoveries, I believe the warning given us by Professor Huxley thirty years ago still holds good. His warning was against the common assertion that it does not signify if coal is used

up or wasted, as science will discover some new source of power; he then showed that there is no other source of power, all other material on earth having long ago combined with oxygen, liberated heat, and is at rest; organic carbon, coal or wood, is the only material that is still in a state of unstable equilibrium ready to combine with oxygen and give out heat.

When we consider the monstrous scale on which the consumption of coal is carried on, the problem of its coming scarcity, if not total exhaustion, will very soon become a subject for practical consideration, and not, as hitherto, a speculation to amuse a leisure hour. Great Britain alone consumes 165 millions of tons every year; this quantity is sufficient to build a wall of coal thirteen feet high and four feet thick right round the world.

It is fair to suppose that the time is not far distant when North and South America, China, Japan, and Australia will, in proportion to their population, consume as much coal as England does, and the quantity would be so enormous that it seems incredible to suppose the supply can last very long. When our fuel is done, civilisation, as we know it, must decline, as it exists only by consuming the products of the earth faster than they can be replaced, or using up such as can never be replaced. The world will look to engineers to make our stores of fuel last for an indefinite time by discoveries in the method of turning heat into power that shall take the place of the wasteful steam engine. Possibly electricity may come to our aid in a new channel if the discovery should be made of producing electrical energy directly from heat without the use of a steam engine.

These anticipations are in advance of our time. At present the only method we have to turn heat into power is to convert water into steam and use the elastic pressure of the steam for our purposes. Mechanical engineers have left no stone unturned to bring the steam engine to perfection, and since it was invented improvements have never ceased. For a long time attention was almost exclusively directed to the engine, which was compounded and jacketed with steam to make the most that was possible out of the expansion of the steam. As economy continually called for more expansion, this, in its turn, demanded higher pressure of steam, which required a thorough re-organisation of the boiler until the latest practice is to employ three, or even four, cylinder engines, with steam of 160 pounds pressure, fresh water

being used in the boiler, even on sea voyages. The economy and efficiency produced by the latest improvements over the old style of marine engine using steam of 18 to 20 pounds pressure has quite revolutionised the steam engine; the test of improvement is generally quoted in the consumption of coal per hour, which is now reduced to about two pounds per horse-power per hour. These improvements in the steam engine, resulting in a greatly reduced consumption of coal per horse-power have, however, no tendency to prevent the increasing consumption of coal; on the contrary, the tendency is for steam to take the place of every other source of power.

The use of coal for warming, ventilation, and cooking is still subject to waste, which may be called shameful, as much of it is wilful, prejudice and custom refusing to listen to suggestions of economy.

The English open fireplace is answerable for an immense waste of fuel, which, probably, equals the total consumption of coal for purposes of power in machinery. The open fireplaces which in winter warm very badly a moderate-sized house, use about as much coal as would drive a ten horse-power engine. When properly used a much smaller quantity of fuel is sufficient for the same purpose, as is seen in the German and American stoves; and in Russia I have seen two armfuls of wood thrown into the peculiar brick stoves used in that country keep the house warm all night.

British and colonial prejudice will not give up the wasteful fireplace unless the engineer or architect gives his attention to the invention of some novelty that shall combine economy with the admitted advantages of the open fire. Warming and ventilation have never received from architects or engineers the attention which the subject deserves, consequently it is imperfectly understood and badly practised; nevertheless, in the interests of the public as regards their comfort, health, and economy, this art is quite as important as that of building bridges, railways, or docks.

In the burning climate of Australia the art of cooling must certainly become as important as that of heating. In the hands of the engineer the power of fuel is turned to most unexpected uses, and the world is startled to see heat used to produce cold. In reality the process is extremely simple, but the promises which were uttered when the refrigerating engines were first invented have not yet been fulfilled. We were promised that it would be as easy to cool houses in

summer as to warm them in winter. The Americans seek to temper the summer heats by an unlimited consumption of ice taken internally; we hope the ingenuity of our young engineers will save us from this barbarous and hurtful way of cooling our overheated bodies, and a grateful public, sweltering under a hot wind, will be delighted to reward the engineer who shall invent comfortable cooling places in their houses.

In proportion to the increasing magnitude and importance of modern engineering works, the corresponding necessity has arisen for sound theoretical and scientific knowledge in the engineer. The complicated structure of large bridges and heavy machinery could not safely be designed by men deficient in mathematical and mechanical science. The day is now past when, to make an engineer, it was considered sufficient to apprentice a youth to an engineer who set him to tracing, plotting, and drawing, taught him the use of the theodolite and level, and sent him to pick up experience on the works. This process turned out a race of so-called practical, or rather rule-of-thumb engineers, now happily dying out.

The scientific and theoretical teaching of engineering is now recognised to be as important as the technical training required for other professions of high standing. Engineering schools and colleges are provided in most large cities, where there is no want of opportunity for the youth of these colonies to acquire the science of all branches of engineering. A good engineer, however, is not manufactured by schools and colleges only, for without the natural bent and mental aptitude the best scientific teaching will lead to disappointing results; there is no profession that demands so wide a range of knowledge, scientific as well as practical, and none in which common sense and sound judgment are so indespensable to success.

Hitherto there has been much laxity and indifference on the part of public bodies as to the qualifications of the men employed by them as engineers, with the result that the profession has had to submit to blame and obloquy for the work of men not properly qualified as engineers. Victoria is the only colony which has recognised the importance, in the public interest, of insisting on public bodies which have charge of public works satisfying themselves that the engineers they employ shall be properly qualified. If this example were imitated by the other colonies the public would reap a manifest advantage.

The profession of engineering is one of the most interesting and attractive in the world: the open air life, the variety and importance of the operations which require the attention of the engineer, the busy life, with constant change of locality, the absence of the monotony common to many professions, and the conspicuous nature of the work in which he takes part, infallibly tend to attract young men to the profession, with the equally infallible consequence of an amount of over-crowding which is the bitter drop in the engineer's cup of bliss, and often brings anxiety and disappointment at the time of life when the young engineer is full of his highest hopes.

Like the soldier and sailor, the engineer is a long-suffering and much enduring man; he cheerfully follows his duty, whether it calls him to the burning plains of India or Australia, the fever haunted wilds of Africa, or the frosty heights of the Andes, and leaving great and enduring works to serve as monuments to the century he lives in, he is content with the most modest recognition of his services, and is satisfied if he has been useful to his country and faithful to his profession.

To the public the engineering profession is the most important of all professions in the domains of peaceful industry; without it the community is helpless, and must retrograde into semi-barbarism. The standard of civilisation, as well as the industry and wealth of a people, are measured by their engineering works, and this is not exclusively a feature of our days. In the remotest times of antiquity, whose records are lost and tradition even is silent, the sight of some vast reservoir, some rows of lofty columns buried in the primeval forest, some great causeway crossing a wild and deserted country, points with certainty to the work of a great and wealthy people now entirely forgotten.

Let these colonies not forget that wealth and greatness are measured by their engineering works, and if they would entertain the honourable ambition, once more popular than now, of being remembered to the distant ages of the future, let them emulate those mighty peoples of the past who left imperishable records of their life in the ruins of their vast public works.

Report of Committee No. 1.

SEISMOLOGICAL PHENOMENA IN AUSTRALASIA.

Members of Committee.—Mr. A. B. Biggs, Mr. R. L. J. Ellery, Sir James Hector, Mr. H. C. Russell, Professor Threlfall, Mr. C. Todd, Mr. G. Hogben (Secretary).

This Report includes the following Colonies—New Zealand, New South Wales, Victoria, South Australia.

1. The first work that this Committee has set itself to do is to compile a list of all recorded earthquakes up to the present time, including in that list all the important details as far as they are given in the records. This work had already been done up to the end of 1890 for New Zealand, although the time, direction, duration, and intensity of shock were not included in the list published in the Third Volume of the Proceedings. In the present Report are included similar records for New South Wales, Victoria, and South Australia up to date, and for New Zealand for the past year (1891), those important details omitted in the former New Zealand records being now included in all cases where possible. The records for Tasmania will, it is hoped, be tabulated in time for our next Report.

2. In the next place, we have attempted to provide for the future recording of earthquake-shocks in all the Colonies according to a uniform system, and are pleased to be able to say that the forms in use in New Zealand have been adopted (with the necessary alterations) in New South Wales, Victoria, South Australia, and Tasmania. A specimen form is annexed to this Report. It is proposed to reduce these returns to tabular form, and to insert the tables for future use in the periodical reports of the Committee. Instructions to the observers are to be sent out with the forms, but it is unnecessary to give them at length here.

Inasmuch as it is, to a large extent, as part of a world-system of observations that our observations in Australasia will become useful, we propose to do for the Islands of the Pacific, as far as circumstances will admit, what is being done for the Australasian Colonies, and have to thank the Rev. Lorimer

Fison for the promise of his good services in this direction. With his and other help much more, we trust, will be done than at first appears possible.

3. In recording the intensity of earthquakes the Committee have felt the want of a common standard, and we have accordingly adopted the Rossi-Forel scale as used by Italian and Swiss seismologists, and (recently) in England also. Though rough and variable to a slight extent, it has the advantage of being a recognised standard, and is suited to the nature of the evidence at our command. As it not easily accessible, we append a translation of it by Mr. Charles Davison, M.A., (*Geological Magazine*, 1891).

4. With regard to the determination of the origins, those for New Zealand, as far as then ascertained, were given in a paper read by Mr. George Hogben, M.A., at the third meeting of the Association (Vol. III.—" New Zealand Earthquakes.") To the " ascertained " origins there given may now be added the origin of many of the earthquakes in Cook Strait. It was found from the earthquake of 5th July, 1891, (*see* paper read before the Philosophical Institute of Canterbury, 1st October, 1891).* The result arrived at is confirmed in a remarkable manner by the fact that the data of the earthquake of the 4th December, 1891, give an epicentrum four miles N.W. of the same spot; and to the same origin we may reasonably assign about twenty other earthquakes felt during the year 1891. It is satisfactory to note that the determination of this origin has been made possible only by the system of time-observations now adopted for Australasia. The earthquake of the 24th June, 1891, was one of the most considerable hitherto recorded in the Auckland District. It is discussed in a paper read by Mr. Hogben before the Philosophical Institute of Canterbury, 4th November, 1891.

In a future report we may be in a position to say what has been done in determining earthquake origins situated in or near the other Colonies.

While satisfactory provision has now been made for proper official or semi-official records, we wish to point out that private individuals may largely assist the work of the Committee by forwarding such facts relating to earthquake phenomena as fall within their notice, and we cordially

* The epicentrum is in Cook Strait, 65 miles from each of the places Blenheim, Masterton, and Marton—or 44 miles nearly N.N.W. of Wellington. The velocity of propagation was between 15 and 18 miles per minute, probably nearly 18; the depth of the centrum is uncertain.

invite any one interested in the subject to communicate with a member of the Committee resident in his own Colony, or with the Secretary, George Hogben, Timaru, N.Z.

Form of Earthquake Memorandum adopted.

*Earthquake at*__________ *N.Z.* *Date*__________189

[Please answer precisely any or all of the following Questions.]

1. Time of beginning of shock. *If possible N.Z. Mean Time.*	
2. Whether clock was verified by N.Z. Mean Time.	
3. Nature of shock—*slight, sharp, or severe.*	
4. Apparent direction—[*e.g.*—S.E. to N.W.; then N.E. to S.W.]	
5. Apparent duration.	
6. Effects. [*e.g.* — *clocks stopped; bells rung; crockery broken; chimneys thrown down.*]	
7. Remarks. [*e.g. previous tremors or rumbling; spilling of liquids, with direction of overflow; landslip in neighbourhood; special instruments used in observation.*]	

*Signature of Observer*________________

*Address*________________

*Date*________________

Rossi-Forel Scale of Intensity.

I. Recorded by a single seismograph, or by some seismographs of the same model, but not by several seismographs of different kinds; the shock felt by an experienced observer.

II. Recorded by seismographs of different kinds; felt by a small number of persons at rest.

III. Felt by several persons at rest; strong enough for the duration or the direction to be appreciable.

IV. Felt by persons in motion; disturbance of moveable objects, doors, windows, cracking of ceilings.

V. Felt generally by everyone; disturbance of furniture and beds, ringing of some bells.

VI. General awakening of those asleep; general ringing of bells, oscillation of chandeliers, stopping of clocks; visible disturbance of trees and shrubs. Some startled persons leave their dwellings.

VII. Overthrow of moveable objects, fall of plaster, ringing of church bells, general panic, without damage to buildings.

VIII. Fall of chimneys, cracks in the walls of buildings.

IX. Partial or total destruction of some buildings.

X. Great disasters, ruins, disturbance of strata, fissures in the earth's crust, rock-falls from mountains.

EARTHQUAKE Shocks in New South Wales, 1880–1891.

A. = A.M.; P. = P.M. (Sydney Mean Time).

Date.	Place.	Time.	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1880. 31 July	Coonamble	5 P.	...	...	Peculiar bumping noise over belt along Castlereagh River, 250 miles long by 50 miles wide. Natives and horses frightened.	Say VI.
26 Oct.	Walcha	1·0 P. A few min. past	...	3 to 4 secs.	Slight report accompanying shock.	IV.
Ditto	Europambela					
1884. 13 July	Eden	2·10 P.	S. to N.	30 secs.	...	III.+
Ditto	Gabo	2·20 P.	S. to N.	10 secs.	...	III.+
Ditto	Bega	1·26 P.	W. to E.	a few secs.	...	III.
19 Sept.	Green Cape	8·40 P.	...	...	Several other shocks in the same month.	IV.+
1885. 18 Jan.	Woollatira	12·56 P.	N.E. to S.W.	...	...	IV.
Ditto	Darlington Road	...	...	...	...	IV.
21 Jan.	Coolamatong	11·15 A.	E. to W.	3 or 4 secs.	...	IV.
Ditto	Bega	11·0 A.	S.W. to N.E.	...	Slight.	III.
Ditto	Cooma	11·10 A.	N. to S.	About ½ min.	...	IV.
Ditto	Nimitybelle	11·5 A.	W. to E.	...	...	III.

Ditto	Adamineby	...	W. to E.	...	...	III.
Ditto	Kiandra	...	W. to E.	...	...	III.
27 Feb.	Green Cape	10·4 P.	S. to N.	50 secs.	Sharp.	III. to IV.
21 March	Gabo	9·25 A.	S. to N.	73 secs.	"Very severe."	At least IV.
13 May	Gabo	9·50 A.	S. to N.	1 min.	"Most severe yet felt."	V.+
Ditto	Green Cape	9·50 A.	S. to N.	2 min.	...	IV.
Ditto	Bega	9·45 A.	W. to E.	1 min.	Severe.	IV.+
Ditto	Candelo	...	...	...	...	IV.
27 May	Cooma	9·30 P.	N. to S.	Some secs.	...	III.+
1886.						
26 March	Mulgoa	7·2 A.	N. to S.	4 secs.	...	III.+
30 August	Young	5·15 A.	W. to E.	Some secs.	Subsequent rumbling.	IV. to V.
5 Sept.	Mt. Poole	About 10 P.	...	3 secs.	Rumbling lasted 30 secs. afterwards.	III.+
Ditto	Milparinka	...	...	...	...	III.
30 Nov.	[NOTE.—This earthquake was felt over a strip of country 150 miles east to west, and 240 miles north to south, forming the S.E. corner of New South Wales. The reports are as follows] :—					
Ditto	Adelong	2·55 A.	..	About 30 secs.	Smart.	III.
Ditto	Bathurst	About 3·0 A.	...	...	Smart.	III.
Ditto	Bodalla	A little before 3·0 A.	...	...	Distinct.	III.
Ditto	Bungonia	2·50 A.*	N. to S.	30 secs. and 1 min.	*Local time. Two shocks, with interval of 10 secs.	III.+
Ditto	Broughton Creek	2·59 A.	N. to S.	40 secs.	...	IV.
Ditto	Cooma	About 3·0 A.	N. to S.	Some secs.	...	III.
Ditto	Gordon	...	...	...	...	IV.
Ditto	Lane Cove River					
Ditto	Gininderra	3·0 A.	N. to S.	About 35 secs.	Severe; heavy rumbling.	IV.+
Ditto	Cape St. George	3·0 A.	...	A few secs.	Severe.	III.+
Ditto	Goulburn	About 3·0 A.	W. to E.	15 secs.	Two shocks. Most severe felt.	IV.+

Date.	Place.	Time.	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1886. 30 Nov.	Grenfell	3·0 A.	...	...	Smart shock, followed by a lesser one.	III. ?
Ditto	Gundagai	3·0 A.	N.E. to S.W.	10 or 12 secs.	Sound heard for some secs. before.	IV. +
Ditto	Gundaroo	3·0 A.	W. to E.	...	Severe.	IV.
Ditto	Gunning	3·0 A.	...	Fully 1 min.	...	IV. +
Ditto	Jervis Bay	3·5 A.	...	A few secs.	Severe.	III. +
Ditto	Junee	3·0 A.	E. to W.	...	Rumbling noises, 9 secs.	III.
Ditto	Kyamba	3·0 A. A few min. after	...	...	Noise afterwards.	IV.
Ditto	Marulan	3·0 A.	E. to W.	...	Sharp.	III.
Ditto	Moss Vale	3·0 A.	...	...	Slight.	II.
Ditto	Murrumburrah	3·0 A.	...	...	Severe.	III.
Ditto	Nowra	3·0 A.	...	7 secs.	Strong shock.	III.
Ditto	Orange	3·0 A.	..	...	Sharp.	III.
Ditto	Penrith	3·1 A.	...	Some secs.	Severe.	III. +
Ditto	Picton	2·55 A.	...	...	Slight.	III. ?
Ditto	Queanbeyan	3·5 A.	W. to E.	1 min.	Severe.	III. to IV.
Ditto	Tumut	3·0 A.	N.E. to S.W.	...	Long rolling rumbling. Housesviolentlyshaken	V. to VI.
Ditto	Wagga	...	...	9 seconds	Severe.	III. +
Ditto	Wild's Meadows	3·0 A.	...	...	2 shocks, rumbling.	III.
Ditto	Yass	2·54 A.	W. to E.	12 seconds	Walls cracked, ceilings fell ; vibration lasted over 2 minutes. Two distinct shocks.	VII. to VIII.

1887.						
28 July	Wilgar Downs	5·0 P.	S.E. or E. to W.	...	Rumbling nearly 1 min.	III. or IV.
Ditto	Girilambone	...	...	..	People rushed out of doors.	VI.
Ditto	Nyngan	...	...	...	Houses shaken.	VI. or V.
Ditto	Cannonbar	...	...	...	Duck Creek rose. Fish thrown out of water.	VII. ?
Ditto	Booroomugga	...	...	...	Severe.	IV.
29 July	Wilgar Downs	...	...	...	...	II.
1888.						
6 July	Sydney					
Ditto	Baw Baw	6·15 A.	N.E. & S.W., or N.W. & S.E.	3-5 seconds	Low rumbling previously. After tremors. More severe at Mummel, 4m. N.W.	IV.
Ditto	Ditto	6·35 A.	N.W. to S.E.	...	...	III.
Ditto	Berrima	6·10 A.	...	...	Followed by slight shocks for 20 minutes.	III.+
Ditto	Broughton Creek	6·30 A.	...	5 seconds	...	III.
Ditto	Collector, Lake George	6·20 A.	N. to S.	...	...	III. or IV.
Ditto	Double Bay, Sydney	6·15 A.	...	15 seconds	...	III.
Ditto	Darlinghurst, Sydney	6·10 A.	...	10 or 12 secs.	...	III.
Ditto	Goulburn	6·10 A.	...	...	...	III. ?
Ditto	Moss Vale	6·15 A.	...	...	...	III. ?
Ditto	Mount Costigan	6·30 A.	E.N.E. to W.S.W.	...	Previous rumbling.	IV.
Ditto	Orange					
Ditto	Picton	About 6·0 A.	...	A few secs.	...	III.
Ditto	Randwick					
Ditto	Wollongong	About 6·15 A.	N. to S.	...	...	III.

Date.	Place.	Time.	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1888.						
6 July	Dapto	...	N. to S.	...	...	III.
13 August	Orange	2·32 A.	...	...	...	IV.
1889.						
4 Oct.	Arakoon	1·30 P.	S.W. to N.E.	...	...	III. or IV.
1890.						
27 March	Orange	3·16 A.	...	10 secs.	2 slight shocks. Rattled furniture.	IV. to V.
4 June	Double Bay, Sydney	A.M.	...	Several secs.	Another shock soon afterwards.	IV. to V.
22 Aug.	Werrina	1·0 A.	...	...	Severe.	III. +
Ditto	Munginidi	...	...	...	35 miles below Werrima, on Macintyre.	III. +
1891.						
15 June	Morpeth	8·40 A.	...	...	Slight vibration till 9·32	IV.
Ditto	Ditto	5·31 P.	...	...	Slight vibration till 6·27.	III. to IV.

EARTHQUAKE Shocks recorded in Victoria since 1884.

P. = P.M. ; A. = A.M.

Date.	Place.	Time. (Melbourne Mean Time.)	Apparent Direction.	Apparent Duration.	Remarks.	Intensity. Rossi-Forel Scale.
1884.						
14 Feb.	Gabo Island	9·57 P.	...	...	Slight.	III.
17 Feb.	Ditto	3·50 P.	...	...	Severe.	VI.

5 March	Ditto	8·10 P.	...	...	Slight.	III.
18 March	Ditto	10·0 P.	...	...	Slight.	III.
27 March	Ditto	9·0 P.	...	...	Very slight.	I. or II.
9 June	Ditto	8·0 P.	...	...	Sharp shock.	IV.
13 July	Ditto	2·20 P.	...	...	Sharp shock.	IV.
Ditto	Port Albert	1·50 P.	...	...	Slight shock.	III.
3 Aug.	Gabo Island	12·20 P.				
7 Aug.	Ditto	10·0 P.				
14 Aug.	Ditto	6·55 A.	...	...	Slight.	III.
16 Sept.	Ditto	9·30 P.	...	...	Sharp.	IV.
19 Sept.	Ditto	8·50 P.	...	...	Severe.	VI.
Ditto	Omeo	8·30 P.				
Ditto	Cape Schanck	8·29 P.				
Ditto	Lakes' Entrance	8·30 P.	...	...	Slight.	III.
Ditto	Wilson's Promontory	8·30 P.				
Ditto	Port Albert	8·35 P.				
1885.						
10 Jan.	Melbourne	3·25 A.				
Ditto	Cape Schanck	3·18 A.				
Ditto	Mornington	3·15 A.				
Ditto	Berwick	3·20 A.	...	...	Severe.	VI.
31 Jan.	Gabo Island	1·5 A.	...	...	Violent shock.	VII.?
9 Feb.	Ditto	1·15 A.	...	...	Slight.	III.
27 Feb.	Ditto	10·0 P.	...	...	Sharp.	IV.
Ditto	Bendoc	10·0 P.				
16 March	Gabo Island	5·15 A.	...	...	Slight.	III.
Ditto	Ditto	9·0 P.	...	...	Slight.	III.
Ditto	Ditto	9·45 P.	...	...	Slight.	III.
21 March	Ditto	9·25 A.	...	...	Very sharp.	V.

Date.	Place.	Time. (Melbourne Mean Time.)	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1885.						
21 March	Wilson's Promontory	9·10 A.				
22 March	Gabo Island	6·5 P.	...	...	Slight.	III.
23 March	Ditto	4·30 A.	...	...	Sharp.	IV.
26 March	Ditto	6·50 P.	...	...	Slight.	III.
30 March	Ditto	9·25 P.	...	...	Sharp.	IV.
4 May	Ditto	9·0 P.	...	...	Sharp	IV.
11 May	Ditto	10·50 P.	...	...	Sharp	IV.
13 May	Ditto	9·50 A.	...	...	Very severe	VII. ?
Ditto	Wilson's Promontory	9·27 A.	...	...	Very severe	VII. ?
Ditto	Lakes' Entrance	9·30 A.	...	...	Sharp	IV.
Ditto	Warragul	9·31 A.	...	...	Severe	VI.
Ditto	Bairnsdale	9·29 A.	...	...	Severe	VI.
Ditto	Melbourne	9·30 A.	...	...	Severe	VI.
27 May	Gabo Island	5·0 P.	...	...	Slight	III.
31 May	Ditto	5·36 P.	...	...	Sharp double shock	IV.
Ditto	Ditto	10·25 P.	...	...	Severe	VI.
3 July	Melbourne	2·0 A.				
Ditto	Cape Otway	2·0 A.	...	...	Slight	III.
Ditto	Flinders	Between 2 & 3 A.	...	...	Severe	VI.
Ditto	Cape Schanck	2·10 A.	...	...	Severe	VI
Ditto	Cowes	2·10 A.	...	...	Severe	VI.
Ditto	Ballarat	2·10 A.	...	...	Slight	III.
Ditto	Tyabb, Hastings	2·0 A.	...	...	Sharp	IV.

Ditto	Melbourne	2·5 A.	...	...	Sharp	IV.
Ditto	Gembrook	1·54 A.	...	...	Slight	III.
Ditto	Kilmore	Early morning				
Ditto	Wilson's Promontory					
Ditto	Gabo Island					
Ditto	Lakes' Entrance					
4 July	Melbourne	12·37 A.	...	...	Slight	III.
17 July	Gabo Island	8·15 A.	...	...	Slight	III.
1 August	Ditto	3·0 P.	...	...	Slight	III.
2 August	Ditto	12·58 A.	...	...	Sharp	IV.
20 August	Ditto	4·12 A.	...	...	Sharp	IV.
11 Sept.	Omeo	7·10 P.				
Ditto	Wilson's Promontory	7·7 P.	...	...	Slight	III.
Ditto	Flinders	7·18 P.				
Ditto	Gabo Island	7·5 P.	...	...	Severe	VI.
13 Sept.	Ditto	2·25 A.	...	...	Slight	III.
8 October	Omeo	9·37 A.				
Ditto	Bright	9·36 A.	...	...	Sharp	IV.
Ditto	Beechworth	9·40 A.				
Ditto	Tallangatta	9·47 A.	...	...	Slight	III.
1 Nov.	Gabo Island	2·32 P.	...	16 seconds	Sharp	IV.
1886.						
3 January	Ditto	10·36 P.	...	...	Sharp	IV.
8 March	Ditto	1·55 P.	...	...	Sharp	IV.
9 March	Melbourne	11·0 P.	...	...	Slight	III.
15 July	Bright	2·17 A.	...	...	Severe	VI.
2 August	Gabo Island	8·55 P.	...	...	Sharp	IV.
30 Nov.	Beechworth	2·40 A.	...	...	Sharp	IV.
2 Dec.	Cape Otway	6·23 P.	...	...	Sharp	IV.

Date.	Place.	Time. (Melbourne Mean Time.)	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1887.						
8 March	Gabo Island	11·7 P.	...	...	Slight	III.
2 August	Cape Otway	5·59 A.	...	...	Sharp	IV.
Ditto	Apollo Bay	6·0 A.	...	...	Sharp	IV.
10 Nov.	Gabo Island	2·13 A.	...	...	Slight	III.
1889.						
29 July	Ditto	6·20 P.	...	...	Sharp	IV.
27 October	Omeo	7·56 P.	...	...	Sharp	IV.
1890.						
18 October	Ardmore	7·0 A.	...	...	Slight	III.
1891.						
7 June	Melbourne	2·4 P.	...	...	Slight	III.
Ditto	Queenscliff	2·6 P.				
Ditto	Sorrento	2·8 P.				
Ditto	Elaine	2·6 P.				
Ditto	Frankston	8·45 P.	...	...	Slight	III.
8 June	Melbourne	1·48 P.	...	...	Slight	III.
5 July	Koroit	8·0 P.	...	...	Sharp	IV.
9 July	Walhalla	3·30 P.	...	...	Severe	VI.
	Ditto	6·40 P.	...	...	Slight	III.
1 August	Melbourne	3·20 P.	...	...	Slight	III.
20 October	Grantville	4·0 P.	...	...	Severe	VI.

EARTHQUAKE Shocks in South Australia since 1882.

A. = A.M.; P. = P.M. (Adelaide Mean Time).

Date.	Place.	Time (approximate.)	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1882.						
4 March	Port Darwin					
Ditto	River Daly, N.T.	3·15 A.	...	Nearly a min.	...	III.
19 March	Strathalbyn	2·0 A.	...	...	Slight	
12 May	Wakooka, Y.P.	...	...	...	Severe	
Ditto	Corney Pt., Y.P.	About 3·0 P.	...	A few secs.	...	III.+
Ditto	Levens, Y.P.	2·30 P.	W. to E.	About 2 min.	...	III.+
16 June	Yednulknie	...	S. to N.	...	Severe	III.+
18 July	Mount Ive Station	10·0 A.	E. to W.	...	Heavy shock	III.+
26 July	Alice Springs	...	W. to E.	...	Severe	III.
18 Sept.	Eastern Suburbs of Adelaide.					
Ditto	N. Adelaide	About 5·0 P.	W. to E.	...	Time doubtful	III.
Ditto	Woodside	5·5 P.			Slight to smart	
Ditto	Gumeracha	5·15 P.				
24 October	Kingston	...	...	...	Slight	...
1883.						
21 Feb.	Blyth	5·45 P.	W. to E.	...	Slight	III.
Ditto	Clare	5·43 P.	S.E. to NW.	30 secs.	Severe	IV.+
7 July	Adelaide and Suburbs.					
Ditto	North Adelaide	11·12 P.	S.E. to N.W.	...	Rapid trembling; four heavy waves, then true shock; and disturbance dying away	V.

Date.	Place.	Time (approximate.)	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1883.						
7 July	Kent Town	11·10 P.	...	...	Distinct shock repeated a few seconds later	III.+
Ditto	Mount Barker	11·14 P.	W. to E.	Over ½ min.	Previous tremors; difficult to stand steady	VI.
Ditto	Strathalbyn	Little after 11·0 P.	...	...	Very severe	III.+
Ditto	Milang	11·15 P.	S. to N.	...	Severe	III.+
	Goolwa	About 11·20 P.	E. to W.	...	Slight	III.
	Gumeracha	About 11·0 P.	W. to E.	Several secs.	...	III.
	Clarendon	A few minutes after 11·0 P.	N.W. to S.E.	...	Two distinct shocks	III.+
26 August	Daly Waters	Abt. midnight	W. to E.	...	Awakened by explosion like blasting	IV. or V.
27 August	Daly Waters, N.T.	9·30 or 10.0 A.	...	...	Similar noise & vibration	III.
	Alice Springs	10·10 A.	...	...	Two distinct explosions	III.
	Sheep Camp	...	...	...	9 mls. west Alice Springs	III.
	Undoolya	...	...	...	25 miles east ditto	
30 October	Port Darwin	2·48 1.	...	...	Slight tremor	II.
1884.						
18 June	Blinman	3·58 P.	N.W. to S.E.	About 3 secs.	Strong	III.
24 June	Port Pirie	11·30 P.	S. to N.	...	Rather severe	III.+
25 June	Port Pirie	3·0 A.	S. to N.	...	Considerable vibration	III.+
Ditto	Gladstone	3·0 A.	N.W. to S.E.	Abt. 15 secs.	Heavy shocks	III.+
Ditto	Appila	About 3·0 A.	E. to W.	Abt. 30 secs.	Heavy shocks	III.+
Ditto	Caltowie	...	N.W. to S.E.	...	...	III.
Ditto	Port Germein	Bet. 3 & 4 A.				

Ditto	Orroroo	3·0 A.	S.W. to N.E.	...	Severe	III.+
15 Sept.	Petersburgh	11·11 P.	...	Several secs.	Heavy	III.
Ditto	Yongala	11·12 P.	S.W. to N.E.	...	...	III.
1885.						
19 Sept.	Clare	Bet. 5 & 5·30 P.	...	...	Several smart vibrations	III.
12 Dec.	Catowie	11·30 A.	S.W. to N.E.	...	Severe vibrations	III.+
Ditto	Jamestown	11·30 A.	W. to E.	...	...	III.
1886.						
26 March	Gladstone	9·37 P.	S.W. to N.E.	Several secs.	Severe } This was felt generally over northern areas; but other stations give no particulars	III.+
Ditto	Caltowie	9·35 P.	N.W. to S.E.	ditto	Severe	III.+
Ditto	George Town	9·40 P.	...	...		
1 June	Strathalbyn	3·15 P.	N. to S.	...	Smart, rumbling	III.
	Echunga	3·15 P.	...	...	...	II.+
	Mount Barker	3·15 P.	...	...	...	II.+
	Hahndorf					
	Stirling East					
	Macclesfield					
	Goolwa	...	W. to E.	...	...	III.
	East Adelaide	3·10 P.	...	...	Slight	II.+
7 July	Caltowie	3·30 P.	N. to S. }			
Ditto	George Town	3·40 P.	... }	About 6 secs.	Vibrations strongly felt	III. or IV.
Ditto	Gladstone	3·44 P.	S. to N. }			
10 July	Clare	4·15 P.	S. to N.	Several secs.	...	III.
Ditto	Gladstone	4·17 P.	...	...	More severe than 7th	III.+
Ditto	Watervale	About 4·0 P.	S.E. to N.W.			
Ditto	Georgetown	4·20 P.	E. to W.	10 secs.	Loud rumbling	III.
11 July	Gladstone	4·20 P.	W. to E.	8 secs.	Very severe	III.+
Ditto	Blyth	4·15 P.	...	...	...	II.+

Date.	Place.	Time (approximate.)	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1886.						
11 July	Watervale	4·20 P.				
Ditto	Hoyleton	4·20 P.	N.W. to S.E.	...	...	III.
Ditto	Caltowie	4·15 P.				
Ditto	Yarcowie	About 4·15 P.	N.E. (?N.W.) to S.E.	...	...	III.
Ditto	Auburn	About 4·0 P.				
Ditto	Koolunga	4·20 P.	N. to S.			
Ditto	Farrell's Flat	About 4·15 P.				
4 Sept.	Tanunda	6·0 A.	W. to E.	...	...	III.
Ditto	Lyndoch	5·50 A.				
t.	Gladstone	5·45 A. 10·45 P.	W. to E.	...	Very loud rumbling	III.
29 Sept.	Saddleworth	4·20 A.	...	Several secs.	...	III.
Ditto	Eudunda	4·15 A.	N.W. to S.E.	...	Loud rumble for 2 mins.	III.
Ditto	Truro	About 4·30 A.	N.E. to S.W.	...	...	III.
Ditto	Kapunda	4·20 A.	N. to S.	About 20 secs.	...	III.
Ditto	Morgan	4·20 A.	W. to E.	1 min.	Loud rumbling; shock felt on steamers	IV.
Ditto	Blanchetown	3·0 A.	...	...	Loud rumble; no vibration	
Ditto	Yarcowie	About 4·0 A.	E. to W.	...	Rather severe	III.
Ditto	Bridgewater	About 4·0 A.	E. to W.	...	Rather severe	III.
Ditto	Watervale	About 4·0 A.				
Ditto	Stockwell	4·15 A.				
Ditto	Greenock	About 4·20 A.				
5 Oct.	Port Adelaide	Bet. 1 & 2 A.	S.E. to N.W.	6 or 7 secs.	Low rumble	III.
6 Dec.	Gladstone	About 3·0 A.	...	Fully 10 secs.	Very strong vibration	III.+
Ditto	Caltowie	3·0 A.				

	James Town	Early A.M.				
1887.						
8 Jan.*	Wilson	About 8·0 P.	N.E. to S.W.	Nearly a min.	Terrific shock	VI. (?)
Ditto	Eurelia	8·5 P.	W. to E.	...	Very severe	IV. or V.
Ditto	Wirrabara	7·50 P.	S.E. to N.W.	50 secs.	Very severe	IV. or V.
Ditto	Georgetown	8·5 P.	E. to W.	Nearly 1 min.	Very severe	IV. or V.
Ditto	Orroroo	8·5 P.	W. to E.	...	...	III. +
Ditto	Yongala	8·0 P.	S.E. to N.W.	Several secs.	...	III. +
Ditto	St. Germein	8·0 P.	E. to W.	...	...	III. +
Ditto	Port Pirie	8·0 P.	S.E. to N.W.	About 30 secs.	Very severe	IV. or V.
Ditto	Terowie	...	N.E. to S.W.	...	...	III. +
Ditto	Hammond	8·5 P.	...	About 30 secs.	...	III. +
Ditto	Blinman	About 8·0 P.	...	...	Preceded by loud noise	III. +
Ditto	Carrieton	8·0 P.	E. to W.	From 15 to 20 secs.	...	III. +
Ditto	Quorn	8·5 P.	...	About 30 secs.	...	III. +
Ditto	Port Augusta	8·0 P.	W. to E.	About 45 secs.	...	III. or IV. +
Ditto	Melrose	8·0 P.	E. to W.	About 12 secs.	...	III. +
Ditto	Caltowie	8·5 P.	S.W. to N.E.	About 15 secs.	...	III. +
Ditto	Gladstone	About 8·0 P.	...	15 secs.	...	III. +
Ditto	Yarcowie	About 7·40 P.	...	...	...	III. +
Ditto	Cradock	About 7·55 P.	S. to N.	About 30 secs.	...	III. or IV. +
3 April	Orroroo	{ 10·40 P. 10·50 10·55 }	S.W. to N.E.	...	Three distinct shocks	III.
14 April	Port Darwin	11·15 P.	...	...	Slight	II.
Ditto	Hallett	10·30 P.	N.W. to S.E.	Several secs.	...	III.
Ditto	Port Wakefield	7·35 A.	...	...	Violent	IV. +

* One of the most extensive and severe shocks ever experienced in the Colony. In places vibration very strong, causing houses to oscillate and inhabitants to leave in terror. Weather previous excessively hot all over Colony.

Date.	Place.	Time (approximate.)	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1887.						
16 April	Mount Bryan	10·45 P.	N.W. to S.E.	1 min.	Loud noise	III. +
Ditto	Yongala	10·35 P.	S.W. to N.E.	Several secs.	Much noise	III. +
Ditto	Gladstone	...	S.E. to N.W.	...	...	III.
Ditto	Appila	10·45 P.	S.E. to N.W.	...	...	III.
Ditto	Hamilton	10·40 P.	N.W. to S.E.	...	...	III.
Ditto	Clare	10·45 P.	...	30 secs.	Very loud noise	III. +
Ditto	Terowie	10·40 P.	E. to W.	...	Very severe	IV. or V.
Ditto	Burra	About 10·30 P.	S. to N.	...	...	III.
Ditto	Yarcowie	10·40 P.	...	About 10 secs.	...	III.
Ditto	Farrell's Flat	10·45 P.	N.E. to S.W.	...	Severe shock	IV.
17 April	Streaky Bay	7·30 A.	N.W. to S.E.	10 secs.	...	III. +
Ditto	Wiltunga	7·30 A.	N. to S.	About 5 secs.	Two distinct shocks	III. +
Ditto	Pt. Victoria	7·45 A.	N.E. to S.W.	...	...	III.
Ditto	Yorketown	About 8·0 A.	...	Several secs.	Slight	III.
Ditto	Warooka	Bet. 7·40 & 7·45 A.	N.W. to S.E.	About 15 secs.	...	III.
Ditto	Pt. Elliston	About 8·0 A.	...	...	Preceded by great noise	III. (?)
Ditto	Pt. Lincoln	7·30 A.	N. to S.	...	Vibrations strong. Most severe here	III. or IV.
Ditto	Maitland	7·40 A.	...	30 secs.	...	III. +
Ditto	Mconta	7·37 A.	...	60 secs.	...	III. or IV.
Ditto	Kadina	7·30 A.	S.W. to N.E.	...	...	III.
Ditto	Adelaide and Sub-[urbs	7·40 A.	S. to N.	About 7 secs.	...	III.
Ditto	Gladstone	...	...	...	...	II. +
Ditto	Appila	...	...	...	...	II. +
Ditto	Clare	...	...	...	...	II. +

22 June	Mt. Bold (near Clarendon)	3·0 A.	...	...	Severe shock. Slightly felt at Clarendon	III. or IV.
7 August	Hammond	1·43 P.	...	Few secs.	Slight	III.
Ditto	Quorn	1·45 P.	...	About 1 min.	...	III. +
Ditto	Yongala	1·45 P.	N.W. to S.E.	...	Rumblings lasted quite a minute	III. +
Ditto	Wilson & Cradock	1·43 P.	...	...	...	II.
17 August	Caltowie	3·45 A.	N.W. to S.E.	...	Smart shock	III. or IV.
1888.						
21 & 22 Apr.	Appila	Bet. 8 P. 21, & 5 A. 22	...	...	Seven distinct shocks; some rather severe	III. to IV.
8 May	Nairne	About 8·30 P.	...	Several secs.	Rather severe	IV. ?
Ditto	Hahndorf	8·20 P.	W. to E.	Few secs.	...	III.
18 June	Blinman	4·30 A.	N. to S.	Few secs.	...	III.
2 August	Farrell's Flat	4·30 P.	...	...	Two shocks	III.
9 October	Pt. Darwin	10·34 P.	N.W. to S.E.	Nearly a min.	Vibration very distinct	III. to IV.
Ditto	Daly Waters	10·35 P.	...	...	Two distinct shocks	III.
Ditto	Katherine	10·38 P.	...	..	Four distinct shocks; second, most severe, lasted about 20 secs.	III. or IV.
30 Dec.	Emu Flat, H.S.	5·0 A.	N.E. to S.W.	Several secs.	Ended in earth tremors	
1889.						
12 Feb.*	Adelaide and Sub- [urbs	4·35 P.	N.E. to S.W.	Half min.	Slight	III.
Ditto	Angaston	4·40 P.	W. to E.	...		
Ditto	Watervale	About 4·30 P.	N. to S.	About 40 secs.	...	III. +
Ditto	Hamley Bridge	4·40 P.	Easterly	...	...	III.
Ditto	Riverton	4·35 P.	N.W. to S.E.	...	...	III.
Ditto	Kapunda	4·35 P.	S. to N.	Some secs.	...	III.
Ditto	Teatree Gully	4·55 P. ?	...	...	...	II. +

* Felt in most parts of the North of the Adelaide District.

Date.	Place.	Time (approximate).	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1889.						
12 Feb.	Clare	4·30 P.	N.W. to S.E.	30 secs.	...	III. +
Ditto	Stockade	4·40 P.	...	...	...	II. +
Ditto	Tanunda	4·45 P.	W. to E.	...	...	III.
Ditto	Freeling	4·32 P.	...	20 secs.	...	III.
Ditto	Auburn	About 4·40 P.	W. to E.	16 secs.	...	III.
Ditto	Farrell's Flat	4·37 P.	N.E. to S.W.	20 secs.	Very severe	IV. +
Ditto	Truro	4·35 P.	N.E. to S.W.	30 secs.	...	III.
Ditto	Blyth	4·36 P.	W. to E.	...	...	III.
Ditto	Hallett	4·37 P.	S. to N.	8 or 10 secs.	...	III. +
Ditto	Hoyleton	4·37 P.	W. to S.	Several secs.	...	III. +
Ditto	Saddleworth	4·30 P.	N. to S.	15 seconds	...	III. +
Ditto	Morgan	4·40 P.	N.W. to S.E.	...	...	III.
Ditto	Yarcowie	4·25 P.	S.E. to N.W.	About 40 secs.	...	III. +
Ditto	Burra	4·38 P.	N.E. to S.W.	...	Severe	IV.
Ditto	Eudunda	4·45 P.	W. to E.	...	...	III.
Ditto	Stockport	4·35 P.	...	...	...	II. +
Ditto	Marrabel	4·30 P.	N.W. to S.E.	Several secs.	...	III.
Ditto	Blanchetown	4·30 P.	N.W. to S.E.	30 seconds	...	III. +
Ditto	Wasleys	4·35 P.	...	Nearly a min.	...	III. +
Ditto	Manoora	4·35 P.	S.W. to N.E.	About a min.	Severe ; plaster cracked	IV. +
11 March	Pt. Wakefield	10·20 P.	...	...	...	II.
Ditto	Pt. Victoria (Y.P.)	10·35 P.	...	About 50 secs.	...	III. +
Ditto	Maitland (Y.P.)	About 10·0 P.	...	...	...	II.
Ditto	Arthurton	Shortly after 10 P.	S.W. to N.E.	...	Rumbling noise for ½ min.	III.
Ditto	Paskeville	...	E. to W.	...	Severe ; plaster falling	IV.

Ditto	Eudunda	10·30 P.	W. to E.	...	Slight	III.
26 March	Farrell's Flat	Shortly before 6·0 A.	N.E. to S.W.	...	Very loud rumbling	III.
3 April	Wilson & Hawker	4·50 A., about 4·45 A.	N.W. to S.E.	About 20 secs.	Smart shock	III. +
17 June	Yunta & Feetulka	About 4·30 P.	S.W. to N.E.	...	Smart shock	III. +
17 July	Jamestown	Between 11 & 12 P.	E. to W.	...	Two distinct shocks	III.
24 July	Eurelia	1·55 P.	S.E. to N.W.	...	Slight	III.
9 August	Beltana	11·15 A.	S.E. to N.W.	...	Strong vibrations; loud noise	III. +
27 Sept.	Clare	About 1·0 A.	N. to S.	...	Smart shock	III. +
7 Nov.	Beltana	9·45 A.	N.W. to S.E.	...	Strong shock	III. +
29 Nov.	Eurelia & Wilson	8·15, 8·19 P.	S.W. to N.E., N.E. to S.W.	30 seconds	Strong vibrations	III. +
Ditto	Hammond	8·19 P.	W. to E.	...	Strong vibrations	III. +
20 Dec.	Head Camp Trans. Contl. Railway	7·15 P.	S.W. to N.E.	30 seconds	Smart shock	III. +
1890.						
23 Feb.	Hawker	10·10 P.	N.W. to S.E.	10 seconds	Severe	III. or IV.
Ditto	Wilson	Few minutes after 10 P.	Travelling N.	...	Unusually loud noise	III.
25 Feb.	Tungkella and Palmer	Between 12 & 1 P.	...	...	Loud noise	II. or III.
5 March	Port Darwin (N. T.)	6·35 P.	...	44 seconds	Slight	III. +
Ditto	Barrundie (N.T.)	6·35 P.	...	...	Slight	II.
Ditto	Pine Creek (N.T.)	6·34 P.	...	30 seconds	Slight	III.
Ditto	River Katherine (N.T.)	7·5 P.	...	...	Slight	II.
Ditto	Ditto	7·7 P.	...	1 minute	Severe	III. or IV.

Date.	Place.	Time (approximate).	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1890.						
5 March	DalyWaters(N.T.)	7·9 P.	...	...	Slight	II.
11 March	Mt. Lofty Hills	6·20 to 6·30 A.	N.E. to S.W.	...	Slight	III.
4 July	Blinman	3·30 A.	N. to S.	...	Shook whole of Tel. Office	IV.
24 July	Eurelia	7·0 A.	S.E. to N.W.	...	Very loud rumbling	III. +
Ditto	Yunta	7·10 A.	...	...	...	II.
Ditto	Jamestown	About 7·0 A.	S.W. to N.E.	...	...	III.
Ditto	Petersburg	About 7·30 A.	...	...	Strong vibrations for several seconds	III. +
Ditto	Booleroo	Few minutes after 7 A.	...	...	...	II.
Ditto	Yongala	7·0 A.	E. to W.	2 or 3 min. ?	...	III. +
Ditto	Orroroo	7·0 A.	W. to E.	Nearly 1 min.	...	III. +
Ditto	Terowie	7·0 A.	S. to N.	...	Houses shook for sev. secs.	IV.
Ditto	Carrieton	7·0 A.	...	Long contin^{d}.	Loud rumbling	III. +
Ditto	Yarcowie	7·0 A.	S. to N.	...	...	III.
5 Dec.	Port Darwin	6·22 A.	...	Several min.?	Slight. Children removed from beds to safe distance from houses. Series of pulsations, unlike the usual wave-like motion.	III. to V.
Ditto	River Katherine	6·22 A.	...	...	Felt at the Telegraph Office, where doors and windows rattled for few minutes	IV.
Ditto	Banjoewangie	6·22 A.	E. to W. ?	...	...	III. +

1891.						
1 March	Eucla (Great Australian Bight)	4·0 A.	W. to E.	Few seconds	...	III.
21 March	Orroroo	8·0 A.	N. to S.	...	Sharp	III. +
7 June	Kapunda	7·20 P.	N.W. to S.E.	...	Slight	III.
Ditto	Stockport	Abt. 6·45 P.	S.E. to N.W.	...	Slight	III.
14 July	Orroroo	3·45 A.	S. to N.	...	Severe	III. +
10, 11 Aug.	Blinman	12 midnight	N. to S. (?)	...	Vibrations strong; low rumble	III. +
29 August	Cavenagh West, P.O.	5·50 P.	...	...	Rather smart. Felt also within radius of 7 or 8 miles, but not at Petersburg	III.
Ditto	Hawker	6·30 P.	E. to W.	...	Cracked ceilings, &c.	IV. +
Ditto	Wilson	6·30 P.	N.W. to S.E.	...	Severe	III. or IV.
Ditto	Gordon	6·30 P.	...	...	Rather severe	III. +
Ditto	Carrieton	6·30 P.	N.W. to S.E.	...	Smart	III. +
Ditto	Cradock	6·30 P.	W. to E.	...	Smart	III. +
Sept. 15	Laura	4·20 P.	N. to S.	...	Slight	III.
Sept. 18	Freeling	6·15 P.	W. to E.	Several secs.	...	III.
Ditto	Kapunda	6·15 P.	S. to N.	Several secs.	Loud rumbling	III.
Ditto	Tanunda	6·15 P.	S.W. to N.E.	...	Buildings vibrated for about 7 secs.	IV.
Ditto	Greenock	6·11 P.	N.W. to S.E.	...	Strong shock	III.
Ditto	Eden Valley	6·38 P.	S.E. to N.W.	...	Slight	III.
Ditto	Gawler	6·15 P.	S.W. to N.W.	...	Low rumbling, followed by vibrations for 5 secs.	III.
Ditto	Roseworthy	6·10 P.	N. to S.	About 30 secs.	...	III. +
October 1	Hammond	11·15 A.	N. to S.	About 3 secs.	...	III.
October 10	Blinman	7·0 P.	N.W. to S.E.	...	Slight	III. +

Earthquake Shocks recorded in New Zealand during 1891. (For previous years, see Proceedings for 1891.)

A. = A.M.; P. = P.M. * Time verified.

Date.	Place.	Time. (N.Z. Mean Time.)	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1891.						
3 January	Wanganui	9·0 P.*	N.E. to S.W.	20 secs.	Jingling of crockery	IV.
13 January	Wellington	11·37¾ P.*	Vert'l. or N.E.	15 secs.	Previous rumbling	III.
22 January	Kaikoura	10·1 A.*	W.N.W. to E.S.E.	3 secs.	...	III.
24 January	Wanganui	12·50	N.W. to S.E.	50 secs.	Sharp	III.
Ditto	Ditto	2·0 A.	...	...	...	II.
17 February	Rotorua	9·14 A.* 9·38 A.* 11·11 A.*	E. to W. and S. to N.	All less than ¼ min.	Twenty shocks between 9·14 and 11·11; the three named were sharp, the rest slight	III. to IV.
9 March	Kaikoura	2·23 A.*	N.W. to S.E.	15 secs.	...	III.
Ditto	Rangiora	2·21½ A.*	W.S.W. to E.N.E.	2 secs.	Another shock at 2·25 A.	III. to IV.
Ditto	Blenheim	2·25 A.*	N.W. to S.E.	2 secs.	Plastered walls cracked	IV.+
Ditto	Wellington	?	...	...	...	IV.?
21 March	Queenstown	6·30 P.*	N. to S.	8 secs.	...	III.
27 March	Wanganui	3·58 A.*	N. to S.	2 secs.	Slight rumbling	III.
3 April	Wanganui	9·34 P.*	N.E. to SW.	6 secs.	Previous rumbling	III.
4 April	Ditto	2·15 A.	...	2 secs.	Slight	III.—
7 April	Masterton	4·46 P.	N.E. to S.W.	2 secs.	...	III.
25 May	Wanganui	3·30 A.*	S.E. to N.W.	1 sec.	Very slight	III.—
Ditto	Ditto	4·4 A.*	S.E. to N.W.	45 secs.	Loud previous sound	III.

2 June	Ditto	4·19 A.*	N.E. to S.W.	30 secs.	Previous rumbling	III.
Ditto	Bulls	4·20 A.*	N.E. to S.W.	17 secs.	Sharp	III.
Ditto	Blenheim	4·23 A.*	W. to E.	2 secs.	Sharp. Previous rumblings	III.
Ditto	Waitotara	4·24*	N.E. to S.W.	12 secs.	...	III.—
3 June	Wanganui	11·15 P.	N.E. to S.W.	...	...	III.
24 June	New Plymouth	10·50 A.	N.E. to S.W.	10 secs.	...	III.
Ditto	Mercer	10·52 A.*	S.E. to N.W.	2 secs.	...	VII.
Ditto	Thames	10·53 A.*	N. and S.	About 8 secs.	Chimney partly shaken down; crockery swung; horses alarmed; two shocks	IV.
Ditto	Cambridge	10·53 A.*	S.E. to N.W.	¾ min.	Clocks stopped. Glasses fell off a shelf.	VI.
Ditto	Helensville	10·54 A.*	S.E. to N.W.	15 secs.	Crockery broken. Articles thrown down. People rushed out of houses.	VII.
Ditto	Tauranga	10·55 A.*	S.E. to N.W.	About 5 secs.	Clock stopped in P.O. Previous rumblings.	IV.
Ditto	Hawera	11·3 A.	S.W. to N.E.	3 secs.	One of the office clocks stopped.	IV.
Ditto	Kati Kati	10·52 A.	N. and S.	2 min.	"Very severe."	IV.
Ditto	Grahamstown	10·53 A.	N. and S.	...	2 shocks.	III. to IV.
Ditto	Coromandel	10·55 A.	S. to N.	Some secs.	...	III. to IV.
Ditto	Auckland	10·54 A.*	W. to E.	15 secs.	Clocks stopped; crockery thrown down, ; chimneys overthrown; bricks dislodged; loud rumbling accompanied shock.	VIII or VII.

NOTE.—Shock of 24 June not felt north of Kaipara.

Date.	Place.	Time. (N.Z. Mean Time.)	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Foral Scale.
1891. 24 June	Waikato	...	...	...	Windows broken; bells rung; children thrown off seats.	VII. to VIII.
Ditto	Hamilton	10·54 A	S. to N.	20 secs.	...	III. to IV.? (perh. VI.)
Ditto	Raglan	...	N. to S.	...	Windows broken; pendulum clock started; loud report.	VII.
Ditto	Waiuku	10·55 A	S.E. to N.W.	15 secs.	Stopped clocks; loud rumbling.	VII.
Ditto	Wanganui	10·55 A*	...	2 secs.	Slight previous tremor.	III.
5 July	Blenheim	10·53 P.*	W. to E. ?	10 secs.	...	III at least.
Ditto	Upper Hutt	10·55 P.*	N.E. to S.W.	3 secs.	Previous rumbling.	III at least.
Ditto	Masterton	10·53 P.*	N.E. to S.W.	About $\frac{3}{4}$ min.	Postmaster awakened.	V.
Ditto	Woodville	10·54 P.*	W. to E.	5 secs.	...	III at least.
Ditto	Marton	10·53 P.*	N.E. to S.W.	8-10 secs.	...	III at least.
Ditto	Foxton	10·55 P.*	N. to S.	5 secs.	Crockery rattled considerably.	V.
Ditto	Wellington	10·55 P.	S.E. to N.W.	5 secs.	...	III at least.
Ditto	Picton	10·52 P.	N. to S.	10-15 secs.	House shook; windows rattled; previous rumbling	IV. to V.
Ditto	Featherston	10·52 P.	N.W.	2 secs.	...	III at least.
Ditto	White's Bay	12·40 P.*	N. to S.	2 secs.	Previous rumbling.	III.
10 July	Manaia	4·48 P.*	N.E. to S.W.	5 secs.	...	III.
Ditto	Nelson	4·47 P.*	N. to S.	2 secs.	...	III.
Ditto	Wanganui	4·46½ P.*	N.E. to S.W.	3 secs.	Previous rumbling.	III.

Ditto	Takaka	4·45 P.	S.W. to N.E.	10-15 secs.	Previous rumbling.	III.
Ditto	Opunake	About 4·50 P.	N. to S.	...	...	IV.
19 July	Wanganui	7·47 P.*	N.E. to S.W.	2 secs.	...	III.
1 Aug.	Gisborne	5·55 A.*	N.W. to S.E.	10-15 secs.	Sharp; previous rumbling	III.
Ditto	Napier	5·57 A.	...	...	...	III. or II.
9 Aug.	Opunake	5·18 P.*	N.E. to S.W.	5 secs.	Previous rumbling.	III.
10 Aug.	Blenheim	10·25 A.*	N. to S.	5 secs.	...	III.
Ditto	Collingwood	10·24 A.*	N.W. to S.E.	2 secs.	...	III.
Ditto	Wellington	10·30 A.*	E. to W.	2 secs.	...	III.
13 Aug.	Kaikoura	1·51 A.*	W. to E.	15 secs.	...	III.
16 Aug.	Napier	10·18 P.*	N. to S.	2 secs.	Two shocks.	III.
20 Aug.	Picton	8·45 P. ?	N. to S.	3-4 secs.	Previous rumbling.	III.
Ditto	White's Bay	9·10½ P.*	N. to S.	...	...	III.—
Ditto	Marton	9·11 P.*	N. and S.	3 secs. each	Two shocks.	III.
Ditto	Otaki	9·11 P.*	W. to E.	15 secs.	Previous rumbling.	III. +
Ditto	Feilding	9·12 P.*	...	...	...	II.
Ditto	Wanganui	9·11 P.*	N.E. to S.W.	5 secs.	...	III.
Ditto	Wellington	9·11½ P.*	N. to S.	10 secs.	Previous rumbling; cracks in plaster, E. and W.	IV.
Ditto	Upper Hutt	9·12 P.*	N.E. to S.W.	3 secs.	Previous rumbling.	III.
30 Aug.	Opunake	4·53 A.*	N.E. to S.W.	2 secs.	Previous rumbling and humming in air.	III.
15 Sept.	Wanganui	9·52½ A.*	N.E. to S.W.	10 secs.	Previous noise.	III.
Ditto	Marton	9·55 A.	...	...	...	II.
16 Sept.	Rangiora	11·47 A.*	S.W. to N.E.	1 sec.	Rumbling just before.	III.
Ditto	Christchurch	11·49 A.*	...	...	...	III. or II.
Ditto	Rangiora	12·41 P.*	N. to S.	1 sec.	...	III.
17 Sept.	New Brighton	9·0 A.	...	...	Tidal wave.	
31 Oct.	Wanganui	2·30 A.*	N.E. to S.W.	15 secs.	Previous report; crockery jingled.	IV.

Date.	Place.	Time. (N.Z. Mean Time.)	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity. Rossi-Forel Scale.
1891.						
19-20 Nov.	Tauranga	3·41 P. to 8·55 A. (20 Nov.)	S.E. to N.	...	16 shocks, of which 4 shocks were felt at Rotorua.	III. to IV.
20 Nov.	Rotorua	1·40 A. to 11·25 A.	E. to W.	...	...	III to V. or VI.
4 Dec.	Wellington	4·40 A.	E. to W. ?	About 10 secs.	Previous rumbling.	IV. to V.
Ditto	White's Bay	4·38 A.*	N. to S.	5 secs. and 2 secs.	Two shocks; previous rumble.	IV.
Ditto	New Plymouth	4·45 A.	N.E. to S.W.	30 secs.	Rumbling; rattling of window frames.	IV.
Ditto	Upper Hutt	4·41 A.*	N. to S.	...	Clock stopped; previous rumbling and tremors.	V. to VI.
Ditto	Palmerston, North	4·38 A.*	N. to S.	20 secs.	Previous rumbling.	IV. to III.
Ditto	Masterston	4·42 A.	W. to E.	Nearly a min.	Two chimneys injured; observer awakened.	VI.
Ditto	Blenheim	4·41 A.*	W. to E.	20 secs.	Subsequent tremors for nearly 30 secs.	IV.
Ditto	Feilding	4·42 A.*	...	30 secs.	Loud rumbling; cattle alarmed	V. to VI.
Ditto	Nelson	4·45 A.	E. to W.	A few secs.	...	III. to IV.
Ditto	Havelock	4·40 A.*	N.W.	5 secs.	Severe.	III. to IV.
Ditto	Foxton	4·40 A.*	S.E. to N.W.	20 secs.	Articles thrown down; clocks stopped	VII. to VI.
Ditto	Wanganui	4·40½ A.*	N.E. to S.W.	50 secs.	...	V. to IV.

Ditto	Opunake	4·43 A.*	S.E. to N.W.	10 secs.	Woke observer. Prolonged tremor, with several shocks. (Another shock—2 secs., N. & S., at 4·48, slighter)	V.
Ditto	Woodville	4·40 A.*	E. to W., then N.E. to S.W.	over a minute	Crockery jingled. Loud explosion, awoke many. Prolonged tremor.	V.
Ditto	Marton	4·40 A.*	N. & S.	12 secs.	Articles rattled. Two shocks: second sharp	IV.
Ditto	Otaki	4·39 A.*	E. to W.	30–35 secs.	Crockery broken. Heavy previous rumbling	VII.
Ditto	Picton	4·40 A.*	N. to S.	20 secs.	Windows rattled; houses shook. Preceded by loud rumble.	V. to IV.
Ditto	Westport	About 4·40 A.	...	2 min.	Windows rattled and buildings shook; (not all awakened)	IV. (or V.)
8 Dec.	Opunake	3·0 A.*	E. to W.	2 secs.	...	III.
Ditto	Wanganui	3·0 A.	S.W. to N.E.	...	...	III.
12 Dec.	Tauranga	3·49 A.	S. to N.	20 secs.	Clocks stopped	VI.
Ditto	Rotorua	3·43 A.*	E. to W.	A few secs.	Woke most people	VI.
Ditto	Maketu					
Ditto	Te Puke					
16 Dec.	Wanganui	2·33 A.	S.W. & N.E.	...	...	III.
22 Dec.	Wanganui	About 10·30 P.	S.W. & N.E.	...	Previous rumbling	III.

Report of Committee No. 2.

THE TIDES OF THE COAST OF SOUTH AUSTRALIA.

Members of Committee.—Professor Bragg, Captain Inglis, Professor Lyle, Mr. R. W. Chapman (Secretary).

VERY little work has been done so far in the way of investigating the nature of the tides along the Australian Coasts, although the records shew many peculiar and interesting features. The only analysis we believe yet done in this direction was performed by Sir W. Thomson and published in a communication to the British Association in 1878; this was an investigation of the results of tidal observations made at Fremantle, W.A., by the Officers of the Admiralty Survey. This Committee since its appointment has been at work upon the records of South Australian tides as recorded by three tide-gauges established at Port Adelaide, Port Pirie, and Port Augusta. The records from the three gauges exhibit the same general features. There is the usual regular semi-diurnal tide, with a well marked diurnal inequality; this inequality changes some time before the first equinox and some time after the second; that is to say, before about the middle of February the morning tide is the higher, but after that, until about the middle of October, the afternoon tide is higher than the morning tide. But the most characteristic feature is what is locally termed the "dodging-tide," which takes place regularly at the neaps; at this period, for a varying interval of about 24 hours, there is no tide at all in the usual acceptation of the term, and the tide-gauge shews an almost straight line, and in all cases the nature of the curve at this time is markedly different from all the rest. For a short time both before and after this also the tide is irregular both as regards time and height. We selected the records from Port Adelaide as being probably the most reliably kept, and these have been subjected to Harmonic Analysis by Captain Inglis and the Secretary. The analysis has been performed by the method elaborated by the Committee of the British Association, and the results are

stated in conformity with their notation. Owing, unfortunately, to the smallness of the scale of the gauge (3 feet to 1 inch), it seemed useless to analyse for the smaller short period tides, but probably all those which have any appreciable effect have been investigated. The tidal curve for 12 months was taken for analysis, commencing midnight February 28th, 1889. As usual, there were a few gaps in the record owing to the breaking down of the tide-gauge at intervals, but these were for the most part short, and fortunately we were able to fill these in from records kept at the Semaphore, close by, of the times and heights of high and low water. The datum-level is the same at both places, and, as the times and heights observed here generally agree very closely with those obtained with the tide-gauge, the missing portions of the curves could be traced in from these observations and the gaps supplied with considerable accuracy. The numerical results of the Harmonic Analysis are given in the table annexed. The lunar and solar semi-diurnal tides have the greatest amplitudes (about 3 feet total range), and are almost of exactly equal value. Sir W. Thomson also found that at Fremantle these two tides are equal, but there their amplitudes are much less than at Adelaide. The declinational tides are comparatively large, the principal diurnal having a total range of 1·67 feet. Evidently these facts give the explanation of the "dodging tides," for near the neaps the lunar and solar semi-diurnals almost destroy one another, and the declinational tides predominate over them. Near the equinoxes, however, when the declinational tides almost vanish, the complete interference of the two principal semi-diurnal tides causes the level of the water to remain almost perfectly constant for perhaps 24 hours, and the nature of the curve at this time is exactly that caused by the interference of two harmonic components.

The principal solar semi-diurnal tide gives, at Adelaide, high-water exactly at 6 o'clock, low-water exactly at 12.

VALUES of the principal Tidal Components at Port Adelaide. (Lat. 34° 51′ S., Long. 138° 30′ E.)

Initial of Tide.	Name of Tide.	H (Mean semi-range in feet.)	K.
			°
S_1	Solar diurnal	·077	122·24
S_2	Solar semi-diurnal.........	1·664	180
M_1	Lunar diurnal	·011	203·88
M_2	Lunar semi-diurnal	1·709	120·77
K_1	Luni-solar diurnal (declinational)	·836	231·07
K_2	Luni-solar semi-diurnal (declinational)	·469	177·16
O	Lunar declinational diurnal	·533	35·96
P	Solar declinational diurnal	·207	231·07
N	Larger lunar elliptic semi-diurnal	·076	113·94

Report of Committee No. 6.

THE FERTILISATION OF THE FIG IN THE AUSTRALASIAN COLONIES.

Members of Committee.—Mr. T. F. Cheeseman, Professor Haswell, Mr. Thomas Kirk, Baron von Mueller, Mr. Skuse, Professor Tate, Professor Thomas, Mr. C. French (Secretary).

THE CAPRIFICATION OF THE FIG.

OWING to a difficulty of getting Members together in order to draw up a progress report countenanced from all sides, it seems best that at the next time the Chairman and Secretary draw up early a statement of their own and circulate such amongst the Members, so as to enable them to give their views on the subject. The Chairman of the Caprification Committee had, at the meeting in Christchurch, given a lengthy verbal explanation of the present state of the question allotted to our investigation, and since then not much information of a reliable nature has been forthcoming from any particular country, except that in California measures had been taken for acquiring there living plants of the Capri Fig by sending a special emissary to Smyrna with a view of introducing the *Blastophaga grossorum* into California, and that this course had also for Australia been recommended at the New Zealand meeting, and, further, that Mr. C. French, the Government Entomologist of Victoria, had initiated some similar measures for Victoria by opening up a correspondence with the British Consul in Smyrna.

The Committee really thinks that similar united efforts should be made from all the Australian colonies if the results obtained at San Francisco should prove sufficiently encouraging to our expectations, namely, that a superior fig for drying could be produced by the caprification method. It seems, therefore, that every opportunity should be seized upon to gain also from other fig-producing countries, either by the issuing of circular letters or by other means, the most recent data as regards the production of the best kind of figs for

drying. It must be remembered that the clever fig-growers of Asia Minor continue to adhere to the system of artificial fertilisation by means of the insect peculiar to the fig, and that it would seem incredible in this enlightened age that these people should still resort to the ancient method, at considerable trouble and expense, if no advantages whatever could be derived from it.

The question, it would seem, simply resolves itself to this: Is the production of the best kinds of dried figs, such as fetch the highest prices in commerce, solely dependent on some few select varieties, cultivated in specially adapted regions, in peculiar soil, and under particular methods for manuring and watering, as all these conditions are likely to be found in many parts of Australia also. In that case the caprification process would simply rest on inveterate prejudice.

On the other side, it is incumbent on us to demonstrate, with the great prospect of fig-production also for drying in these colonies, how far the action of the *Blastophaga* does really affect the constitution of particular varieties of figs, as it seems quite within the range of possibility that to some sorts of fig the pollination may prove of distinct advantage, and to others not. (See Gasfarrini, Researches on Fig and Capri Fig, 1845 to 1860). This seems clearly to demonstrate that the enigma could best be solved if the Agricultural Departments of the different colonies would unite in finding the means—not necessarily very costly—of sending an expert who, by autopsy, could investigate the question by spending a season in Asia Minor amongst the fig-growers there. If speedy action of this kind, on a recommendation of the Hobart meeting of the Australasian Association, be taken, we might then have the results ready in time for the Adelaide meeting, and the conclusions arrived at would probably be final.

Should the horticulturist who may be entrusted with this mission be convinced by local inspection that the fertilisation of the fig is decidedly recommendable, whether through the physiologic stimulus thereby given or by some other yet obscure cause, then we could secure for the Australian colonies a supply of plants of the caprification fig in an ova-bearing state, as the mere raising staminate fig-trees from seeds, or their importation in a living state, would be of no avail, just as has been the case in California; for we could of course easily obtain seedlings of the staminate fig-tree from carefully preserved seeds of the Smyrna fig.

All the plants examined by us from Australia were pistillate only. The researches of Count Solms Laubach, Director of the Botanical Gardens of Strasburg, and Brigade-Surgeon Dr. King, Director of the Botanical Gardens of Calcutta, have cleared up within the last few years all doubts about the functions of the staminate, pistillate, and neuter flowers in the cultivated fig *Ficus carica*, so that we now know why only the caprification fig is fit for a deposition of the ova of *Blastophaga grossorum*, or, as it was formerly called, *Cynips psenes.* Much valuable information on this subject may be obtained also from Gustav Mayer's work on insects inhabiting various species of *Ficus.*

The Chairman has placed himself in communication with Professor Hillgard, of the Rural Experimental Station of Berkely, California, and with Captain Ellwood Cooper, the most enterprising of all fruit-growers, and President of the Californian State Board of Horticulture, Santa Barbara, to elicit information about the movement set going in reference to the caprification in California, so that in Australia we might be early benefited from these experiments and any results arising from them.

Report of Committee No. 10.

ANTARCTIC EXPLORATION.

Members of Committee—Mr. J. H. Baker, Mr. James Barnard, Mr. F. R. Chapman, Mr. R. L. J. Ellery, Mr. G. S. Griffiths, Baron von Mueller, Mr. Percy Smith, Captain Pasco (Secretary).

At the meeting of this Association held in Christchurch, New Zealand, a Committee, consisting of Baron Sir Ferdinand von Mueller, K.C.M.G., Colonel R. L. J. Ellery, C.M.G., Commander C. Pasco, R.N., G. S. Griffiths, Esq., F.G.S., H. Baker, Esq., F. H. Chapman, Esq., and Percy Smith, Esq., was re-appointed for the purpose of watching over the interests of Antarctic research, more especially in regard to the projected Swedish Australasian Antarctic Scientific Exploring Expedition to be sent out under the command of Baron Nordenskjöld. Of this Committee Commander Pasco was appointed Hon. Secretary.

As the Members resided in different Colonies, no regular meetings could be arranged. Nevertheless, your Committee are able to report that considerable progress has been made. Correspondence continued by the Antarctic Committee in Melbourne with the Royal Academy of Sciences, Stockholm, resulted in an assurance being given by Baron Nordenskjöld that a sum of £15,000 would be sufficient to equip an efficient scientific expedition. On receipt of this assurance the Hon. Sir Thomas Elder, G.C.M.G., promised the Committee a subscription of £5000, on condition that an equal sum be subscribed by the public, this being an equal amount to that promised by Baron Oscar Dixon.

The Committee at once adopted measures for obtaining subscriptions to make up the £5000 balance required. Commander Pasco, R.N., (President of the Committee), and the Rev. W. Potter, F.R.G.S. (now Hon. Secretary of the Committee), were sent to Sydney during the sitting of the Federal Convention in order to co-operate with the Council of the Sydney Branch in an endeavour to get the Honourables the Premiers and Treasurers of the various Colonies represented at the Convention to aid the Expedition by Government grants. As the result of this mission the following

amounts were subsequently placed upon the Budgets for 1891 by the Governments named :—New South Wales, £1334 (conditional on the sum of £666 being raised by public subscriptions); Queensland, £1000; and Tasmania, £500. Although the Queensland Government were unable to carry the vote in Parliament, your Committee have reason to believe that the grant will again be brought before the Legislature next Session, and with a more favourable result.

Mr. A. C. MacDonald, F.R.G.S. (Hon. Treasurer of the Antarctic Fund) reports the present position of the subscription list to be as follows :—

	£
Hon. Sir Thomas Elder, G.C.M.G.	5000
Robert Reid, Esq.	1000
Royal Geographical Society of Australasia, Victorian Branch	200
Subscriptions raised by the Council of the New South Wales Branch of the Royal Geographical Society of Australasia, including £100 from its President, the Hon. E. C. Merewether, M.L.C.,—about	260
Royal Society of Victoria	100
Prof. W. Kernot, M.A., C.E., F.R.G.S	100
J. L. Currie, Esq., F.R.G.S.	100
J. S. Gotch, Esq., (Gordon and Gotch)	100
Dr. W. Agnew, M.L.C.	100
Royal Society of Tasmania	50
Subscriptions under £50 each—about	200
Amount placed upon the New South Wales Budget	1334
Amount placed upon the Tasmanian Budget	500
	£9044
To this has to be added the subscription promised by Baron Oscar Dixon	5000
Total	£14,044

The Trustees of the Antarctic Fund are :—Consul H. Gundersen, Consul-General Sweden and Norway; Colonel R. L. J. Ellery, C.M.G., Government Astronomer; and Commander C. Pasco, R.N., President Antarctic Committee. Subscriptions as they come in are placed by the Hon. Treasurer to the credit of the Trustees in the Commercial Bank, Melbourne.

Your Committee cannot help expressing surprise that the Governments of Western Australia and New Zealand, the two Colonies most prominently commercially benefited by

the development of Antarctic Whale Grounds, should have declined to contribute anything to the Expedition Fund. Doubtless the severe commercial depression experienced throughout Australasia during the past year had something to do with this refusal. However, the brightened prospects of the new year induce the belief that both the Colonies named and those of South Australia and Victoria, which are also largely benefited by the opening up of this long neglected source of national wealth, will, on a fresh appeal being made to them, be found willing to give substantial aid to the Expedition.

It is gratifying to find that Northern whalers are at length becoming alive to the importance of the Antarctic Whaling Ground, and that the Messrs. Gray Bros., of Peterhead, are forming a Company with a view to the fitting out of whaling vessels, making the Falkland Islands their starting-point for Antarctic Seas. No doubt our many years of effort in Australia have tended to bring about this result. In the proposal originally made by the Antarctic Committee, that whaling should be combined with scientific exploration, the intention was to follow up Sir James Clarke Ross' discoveries in South Victoria Land. But whatever meridian the South Pole may be approached by cannot fail to bring important additions to our present defective knowledge of Antarctic geography.

During the year three very instructive discourses upon the subject of Antarctic Exploration have been delivered. One by Mr. G. S. Griffiths, F.R.G.S., at a public meeting convened by the Antarctic Committee, Melbourne; another by Dr. J. J. Wild, Secretary to the Scientific Staff of the *Challenger* Expedition, to the Members of the Royal Geographical Society of Australasia, Sydney, on which occasion His Excellency the Governor, the Earl of Jersey, presided; the third by Mr. E. Du Faur, F.R.G.S., also before the New South Wales Branch of the Royal Geographical Society of Australasia.

The Antarctic Committee has always been most anxious that the ships of the Expedition should reach Australia before the end of 1892, and persistently urged that view upon the Academy of Sciences, Stockholm. It now appears this will be impossible of realization. At its recent meeting the Committee received a letter from Consul Gundersen enclosing a communication addressed by Baron Nordenskjöld to the Minister of Foreign Affairs, dated Stockholm, 23rd September,

1891, in which the Baron says :—"Your Excellency,—On account of a letter from the Australian Antarctic Exploration Committee to the Royal Academy of Sciences, which letter has been communicated to me, and in which regrets are expressed that the projected Antarctic Expedition in no way can be ready to start next year (1892), I beg once more to call your attention to the fact that an Expedition like this, in order to be successful in a way corresponding to the sacrifices made, must necessarily be prepared and fitted out with the utmost care. Consequently, and owing to the experience I have gained in fitting out several former Expeditions, I am of opinion that it is absolutely necessary not to hasten the departure of the Expedition. I think it most convenient to calculate the departure in such a way as to make the Expedition arrive in September, 1893, at its last coaling port and starting-point in the Southern Hemisphere; from thence the Expedition ought to go direct to its destination."

The Committee at once admitted the reasonableness of Baron Nordenskjöld's views, and sent a reply to that effect, and also to say that immediately on the receipt and approval of the promised business details of the Expedition the amount raised by the Committee would be placed at the command of the Academy of Sciences.

Your Committee desire to record their high appreciation of the untiring zeal, supported by the clear conception of the needful requirements of the Expedition, with which the noble and erudite President of the Victorian Branch of the Royal Geographical Society of Australasia (Baron Sir Ferdinand von Mueller) has seconded the efforts of the Antarctic Committee throughout the year.

We must emphatically press on the attention of the Australasian Association that another season will be lost unless in the earliest part of 1892 the fund required can approximately be completed; because ships fit for so arduous an enterprise that are available during the Northern winter (and amongst which is the celebrated steam yacht *Pandora*) will be all under new engagements for the North, unless the needful funds be speedily forthcoming for securing one or another of these vessels.

CRAWFORD PASCO, R.N.,
Hon. Secretary Australasian Association Antarctic Committee.

Committee No. 11.

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Members of Committee.—Revs. J. Copeland, C. Ella, Dr. D. W. Wyatt Gill, J. W. Stock, Mr. E. Tregear, Drs. T. M. Hocken, and Frazer (Secretary).

[See Vol. II., A.A. for Advancement of Science, p. 293.]

NOTE.—The Bibliography contains the names only of those books and pamphlets which have been issued in a separate form, and which give information about the races or their languages. In addition to these many valuable papers may be found in the Journals of the Royal and other learned Societies of the various Colonies of Australasia, and in the Journals of the Anthropological and Geographical Societies of London, &c.

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PROCEEDINGS OF SECTIONS.

Section A.

ASTRONOMY, MATHEMATICS, PHYSICS, AND MECHANICS.

PRESIDENT OF THE SECTION:

W. H. BRAGG, M.A., *Professor of Mathematics, University Adelaide, S.A.*

1.—THE ASTRONOMICAL EXPLANATION OF A GLACIAL PERIOD.

By SIR ROBERT BALL, *Astronomer Royal of Ireland.*

It has been often suggested that there might be some astronomical explanation of that remarkable period in the earth's history which geologists designate as glacial. Indeed, it is doubtless known to the members of this Association that the late Dr. Croll discussed the subject at much length in his ingenious work entitled *Climate and Time*. I have recently undertaken the investigation of the astronomical foundation of the theory at which Croll has laboured. I found, much to my surprise, that this capable geologist was quite unacquainted with the true astronomical doctrine on the subject. He had been doubtless misled by a strange passage in Sir John Herschel's well-known book *The Outlines of Astronomy*. It seems that this eminent astronomer made a curiously erroneous statement in a matter bearing directly on the causes of glaciation. It was perhaps not unnatural for other writers to accept without question a proposition of a mathematical character when it seemed to be authenticated by so illustrious a name as that of Herschel. Anyone, however, who possesses sufficient mathematical knowledge will be able to convince himself that Herschel wrote down hastily a statement which was quite wrong. There is not the least doubt that Herschel himself would have readily admitted

that he had made a mistake if his attention had been sufficiently given to the matter. The worst of it is that Croll and other writers adopted Herschel's mistake as a scientific verity, and reared on this untrustworthy foundation no small superstructure of figures and arguments.

It is the object of this paper to indicate clearly the character of the error to which I have referred, and to substitute for it the correct mathematical theory. It will not be necessary for me to enter into the subject at any great length, for I have fully developed it in a little work which is already through the press, and which will perhaps have appeared by the time this paper is read. I believe, however, that the subject will be of sufficient interest to justify me in giving some account of it to your Association. I feel that I am already in some degree known to those who may hear this paper, at least if I may judge from the number of readers that my little book *Starland* seems to have found in the southern hemisphere.

I will say once for all that the rectification of the error to which I have referred makes the astronomical theory a far more potent factor in the explanation of ice ages than appeared to be the case so long as the erroneous view was entertained. Let me at once commence to explain the matter.

It is the radiation from the sun which prevents the surface of the earth from having a temperature nearly as low as that of space itself. We shall certainly not exaggerate if we suppose that our earth when deprived of sunbeams would have a temperature at least 300 deg. Fahr. below that which it has at present. It is essential to bear this fact in mind, for it thus becomes evident that a small relative fluctuation in the total amount of heat received by the earth may cause a large alteration in terrestrial temperature. For the sake of illustration we may assume the change of temperature to be proportional to the change in the amount of heat received. On this supposition an alteration of one-tenth in the heat received would cause a change in temperature to the extent of 30 deg. I do not, however, maintain that the connection between temperature and the receipt of solar heat is at all so simple as is supposed. My object will have been gained if the illustration suffices to show that even so great a climatic change as the advent of an ice age supposes does not necessarily require any very large proportional alteration in the daily receipt of heat from the sun.

Suppose that the total heat received from the sun on one hemisphere of the earth during the course of a twelvemonth be represented by 100, we proceed to consider how these parts are shared between the seasons. I mean by "summer" in the northern hemisphere the interval from the vernal equinox to the autumnal, and by "winter" the interval from the autumnal equinox to the vernal. With this understanding 63 parts of heat are received on each hemisphere during its summer and the remaining 37 parts during the winter. It is the announcement of this law of distribution which forms the novel feature in the present communication. Herschel's erroneous statement was to the effect that the heat was equally distributed, so that 50 parts were received in summer and 50 parts in winter. Accurate knowledge on this point is of essential importance in attempting to understand the cause of an ice age.

We have now to consider the other factor in the astronomical theory: it arises from the perturbation of the earth's orbit by the influence of the planets. At present the ellipse which forms the earth's orbit differs but little from a circle. Its form is, however, not permanent. The disturbances caused by the other planets, especially Jupiter and Venus, makes the eccentricity to fluctuate when sufficiently long periods of time are contemplated. In the lapse of hundreds of thousands of years the shape of the ellipse oscillates between the circle and the oval, so that not once or twice, but many times, in the course of geological time the orbit described by our earth has assumed a relatively extreme type. We are able to form an estimate of the eccentricity possessed by the orbit when all the circumstances conspire to make it as eccentric as possible. In the extreme case one season of the year may amount to as much as 199 days, leaving but 166 for the other. The contrast between this condition of things and the present condition will be best realised by observing that the difference between the lengths of the seasons at present is only seven days, while in the extreme case it may amount to so much as 33 days.

We have now obtained the numerical elements on which the astronomical explanation of an ice age depends. We have seen that under all circumstances 63 per cent. of the total heat on the hemisphere must be received in summer and 37 per cent. in winter. This statement is true whatever be the shape of the ellipse described by the earth or whatever be the direction in which the line of equinoxes crosses

the elliptic. It will remain true even when one of the seasons is 166 days and the other 199.

There are two cases to be specially considered. First, that in which the summer is 166 days and the winter 199; second, that in which the summer is 199 days and the winter 166. There will be a profound difference between the climates in the two cases supposed. Let us take the first, in which the summer is as short as it is possible for that season to become. The hemisphere must then receive 63 parts of heat in the comparatively brief period of 166 days. The result is a summer intensely hot so far as the direct radiation from the sun is concerned. The winter which follows has now its greatest length, and 37 parts of heat have to suffice for 199 days. The temperature in that season must therefore sink extremely low. The hemisphere under consideration will therefore have very hot and short summers, and very long and cold winters. The circumstances are such as would enable the winter deposit of ice and snow to increase from year to year. Thus would be provided the ice sheet characteristic of a glacial period.

As the summer in the northern hemisphere is simultaneous with the winter in the southern, and *vice versâ*, it follows that on the unglaciated half of the earth there will be a long summer of 199 days, and a short winter of 166. According to the invariable rule 63 per cent. of the total heat received per annum by that hemisphere will arrive during the long summer of 199 days, while 37 per cent. will remain for the winter of 166 days. It is evident that this hemisphere will have a far more equable supply of heat than the opposite one, for the larger portion of the yearly supply of heat is appropriated to the longer season, leaving the lesser portion for the shorter season. Is not this exactly the climatic condition that we should most desire? In those latitudes which we commonly call temperate we often experience too much heat in the summer, and we would generally like a little more in the winter. That is because our two seasons are of nearly equal length. We get 63 per cent. of our total heat supply in the six summer months, and 37 per cent. in the six winter months. The climate would certainly be more uniform if we could arrange to have the 63 per cent. distributed over seven months, and the remaining 37 per cent. over five months. So perfect an adjustment as this seems, however, never to have been realised; for the difference between the lengths of the seasons can never have been so

much as two months, in fact it never can amount, as I have already stated, to more than 33 days. I trust, however, I have made it plain that there must be a wide distinction between the climates of the two hemispheres when the difference between the lengths of the seasons becomes considerable. In the more fortunate hemisphere the temperature would be much more uniform than we have it at present, in the less fortunate hemisphere the seasons of summer and winter would be intensely contrasted. In the latter case we find the conditions requisite for a glacial period, while the other hemisphere will be exceptionally genial.

It is an essential feature of the astronomical theory of the ice age that the glacial condition in one hemisphere must be accompanied by a genial condition in the other. We are thus able to explain not only those indications of glaciation which the rocks afford, but we can also account for the comparatively mild periods which seem to have occurred occasionally in the course of geological time. We can even exhibit in some degree the law by which glacial conditions and genial conditions succeed each other. I desire it to be particularly understood that I do not now attempt to assign any date to the last glacial period. There is, however, one chronological element in the subject of which we can feel sufficiently confident, and which I now proceed to explain.

Let us suppose that the earth's orbit has reached a condition of maximum eccentricity. As the rate at which the eccentricity changes is very slow we shall find that the earth's orbit will preserve for a protracted period sufficient eccentricity to produce a considerable difference between the lengths of the seasons when other circumstances conspire. Let us further suppose that the northern hemisphere is the glaciated one, and that the southern is in a genial condition. Quite independently of any change in the eccentricity, there is a well-known cause in operation to prevent the conditions we have supposed from being permanent. Owing to the phenomenon of "precession" the line of equinoxes rotates in the ecliptic with a period of 21,000 years relatively to the axis of the earth's orbit. It follows that in 10,500 years after the glaciation of the northern hemisphere is at its maximum the glaciation is transferred to the southern hemisphere, and the inter-exchange is complete, for a genial period arrives to cheer the desolated North. Nor will this be permanent, for the eccentricity declines so slowly that it will often be considerable even after the lapse of another

10,500 years, and then the original condition of things will be restored. The ice will go back to the North, the genial phase will again gladden the South. In fact, so long as the eccentricity remains high there will be an oscillation of ice from the North to the South and back again with a corresponding interchange of the genial conditions. How many times this may happen at any particular epoch of maximum eccentricity I do not now attempt to say. It is, however, certain that the gradual return of the earth's orbit to a nearly circular shape will prevent its indefinite repetition. After the lapse of hundreds of thousands of years the orbit of the earth again elongates to an oval, and a recurrence of the phenomena that I have just described takes place.

The conclusion to which the astronomical theory leads us is that in the course of time there must have been several occasions on which the necessary condition of glaciation were found to concur. The dates of the several ice ages must have been very irregular, there being, however, a certain tendency among them to cluster together in groups, separated by the comparatively brief interval indicated by the precession of the equinoxes. It is, however, essential for me to add that the severity of the different ice ages must have shown many varieties, graduating from the most intense down to a condition hardly differing from the climates with which we are familiar.

I have endeavoured to assign its true proportions to the astronomical factor which has, I believe, been a potent influence in the climatic changes of our globe; but it must not be understood that I overlook the geological agents which have undoubtedly contributed in no small degree to the modification of climate. It will be here sufficient to mention a single fact to illustrate how the results that would be brought about by the operation of purely astronomical causes are often altered by terrestrial conditions. The fact that 63 per cent. of the heat on our hemisphere comes in summer, and 37 per cent. in winter, would seem to require a vast difference between the winter temperature and the summer temperature even with nearly equal seasons as we have at present. But in the British Isles or in Tasmania the proximity of the ocean has such a moderating effect on temperature that the range between summer and winter is greatly reduced. To find normal temperatures so far as the astronomical conditions are involved, we must look to some locality where the moderating elements are insignificant.

We find such in Siberia, where in some places the difference between the lowest winter temperature and the highest summer temperature is as much as 150 degrees Fahr. The astronomical theory is here properly exhibited.

Finally, the astronomical doctrine demonstrates that vast climatic changes must have taken place at remote periods in the earth's history, so that even if geologists had not already discovered traces of glacial periods, the mathematicians would have known that they must have existed, and would be urging the geologists now to find them.

2.—ON THE CONDUCTIVITY OF SOLUTIONS OF COPPER SULPHATE.

By W. H. STEELE.

[*Abstract.*]

THE following results were obtained from a very great number of observations on solutions of various concentrations of pure copper sulphate ($CaSO_4 + 5H_2O$). Kohlrausch's method of measuring the resistances was employed.

I. Effect of change of temperature on conductivity. The cell used was a glass tube about 1 cm. in diameter and 20 cms. in length, with each end fitting into necks in the sides of copper cups, whose inner surfaces were the electrodes with areas of about 80 sq. cms. These cups were closed at the top with blocks of india-rubber and connected with Liebig condensers. If R be the resistance of the cell when filled with the solution and σ be the specific resistance, R $= \frac{l}{\pi\gamma}\sigma$ where γ is the mean radius and l is the length increased by $\cdot 8\gamma$ at each end. The conductivity κ is the reciprocal of σ, and $\frac{l}{\pi\gamma}$ is a constant determined once for all by measurement; its logarithm is 1·2540. Thus $\kappa = \frac{l}{\pi\gamma} \cdot \frac{1}{R}$ and $\log \kappa = 1\cdot 2540 - \log R$, so that the calculation of κ from observed value R is simple. From the observations I had first to find the law of variation with temperature, and secondly, the variation with concentration. The former is given approximately by $\kappa_t = \kappa_{20}\,(1 + at - \beta t^2)$, where I have taken 20° C. as standard and t the excess of the temp. C. over 20°. I find the mean value of $a = \cdot 0229$, $\beta =$

·000121. The values of a and β are fairly constant for all concentrations, but not quite so. The mean values give a maximum conductivity at 115° C., but this position is not constant, as it is sometimes below 100°. Its position seems to vary with very small impurities.

The relation between concentration and conductivity is given by the formula $\kappa = an^b$ where n is the percentage of salt in the solution, and a and b are constants. $a = \cdot 00403$, $b = \cdot 766$. The general expression for the conductivity thus becomes $\kappa = \cdot 00403 \times n^{\cdot 766} (1 + \cdot 0229t - \cdot 000121t^2)$.

II. Effect of pressure on conductivity. These results only apply to pressures not greater than atmospheric. The experiments were hardly more than qualitative, but, indicated the following facts:—

i. The conductivity under atmospheric pressure is much less than that under the pressure of a few cms. of mercury.

ii. There is probably a minimum conductivity at a pressure of about 65 cms.

iii. The fall is much more marked in strong solutions than in weak ones, the total decrease varying from 9 to 18 per cent. of the whole amount.

3.—ON A PROPERTY OF ALGEBRAIC CURVES.

By J. H. MICHELL.

[*Abstract.*]

THE author showed, by the use of complex variables, that the following theorem was true of an algebraic curve of the n^{th} degree:—

A circle being drawn through a fixed point to cut the curve in 2^n *points and these joined by* n *chords, the product of the perpendiculars from the fixed point on the chords is constant, being independent of the size and position of the circle, and a function merely of the position of the fixed point.*

4.—ON THE BULGING OF FLAT PLATES.

By J. H. MICHELL.

[*Abstract.*]

THE author investigated the general differential equations by means of which the instability of a plate in the flat form under boundary stress in its plane is determined.

If P, Q, U in the elements of stress at the point (x, y) in the flat form, and a the normal displacement, the areal differential equation is—

$$2\mathrm{A}\ \Delta\ 4_{\mathrm{W}} - \frac{d}{dx}\left(\mathrm{P}\frac{dw}{dx} \times \mathrm{U}\frac{dw}{dy}\right) - \frac{d}{dy}\left(\mathrm{Q}\frac{dw}{dy} + \mathrm{U}\frac{dw}{dx}\right) = 0$$

where $\Delta^2 = \frac{d^2}{dx^2} + \frac{d^2}{dy^2}$.

In particular the symmetrical bulging of a circular plate under uniform radial pressure was worked out. The result arrived at was the following comparison:—

> Suppose the circular disc to be subjected to uniform radial pressure P per unit length, and a strip of the same material and of unit breadth has forces P applied at the ends: then the critical radius of the disc is nearly two-thirds the critical length of the rod,—supposing Poisson's ratio to be one-fourth.

5.—THE TASMANIAN EARTH TREMORS.

By A. B. BIGGS.

[*Abstract.*]

THIS paper discusses the share which our island has had in the general seismic disturbances throughout the world which has characterised the decade just passed, taking up our tremors from the initiation of the series about May, 1883, to its apparent cessation within the last year.

The most noteworthy shocks were given, in the order of dates, as follows:—13 December, 1883; 27 May, 13 July, 19 September, 1884; and 13 May, 1885,—this last being considered the climax of these series.

The two questions which would naturally press for solution at the earliest stage of this new experience would be:—1st, as to the actual magnitude of the shock; and 2nd, its

source or focus. These questions the author discusses at considerable length, detailing his various experiments and apparatus, by which he proves that the popular notion as to the magnitude of the earth motion is a very greatly exaggerated one, and that personal impressions are wholly unreliable, owing probably to our natural sensitiveness to vibration. With regard to the second question, the author infers that our impressions are no more to be trusted as to the *direction of motion* than as to its magnitude. Further, that mere local apparatus, however perfect, is not to be trusted in this respect, as it can only record the *molecular* motion, which is quite distinct from the wave progression. The only reliable means of determining the direction of the lines of progression, and, from their convergence, the focus of the disturbance, is by finding the synchronous curves from an analysis of the times at which the shock is felt in different localities, or, under favourable circumstances, by the direction of the sound. It is assumed that the earth-wave progresses in a more or less irregular expanding circle, just as a ripple from a stone thrown into a pond progresses all round from the centre outwards.

The application of this principle was, however, rendered difficult in our case by the unreliability of the times as reported, and in most cases the limited range embraced by the reports. The three greatest shocks were those of the 13 July and 19 September, 1884, and 10 May, 1885. The result of the analysis of each of these was to locate the focus far away to the eastward in the direction of and near to New Zealand,—a result quite contrary to the popular notion and even to the author's preconceived ideas. The subsequent violent outbreak in New Zealand, however, gave strong countenance to the conclusion arrived at.

In the author's opinion our tremors are, at least to a large extent, merely the sympathetic vibrations from violent disturbances in distant localities, in illustration of which a lengthy table is given of closely approximate coincidences of many of our important tremors with violent shocks elsewhere. The author has failed to find any apparent connection between our tremors and either barometric fluctuations or lunar phases or positions.

6.—ON SOME OF THE DIFFICULTIES OCCURRING IN THE PHOTOGRAPHIC CHARTING OF THE HEAVENS.

By R. L. J. ELLERY, *F.R.S., C.M.G.*

[*Abstract.*]

It is found from the experimental work at the Melbourne Observatory that the exposure necessary to obtain a measurable image of a star the diameter of this image must be over 3″; if it be of less diameter we find the image of insufficient density to measure *with certainty.* This is larger than some astronomers state is sufficient according to their experience, but I think they must be satisfied to measure a disc that can be measured only with some uncertainty, unless indeed different instruments give different results. We have come to the conclusion that with our telescope no disc is black enough to measure unless it is 3″·75. If this be true generally, we have the diameter of the disc as a measure of the density, and the question of duration of exposure for the 11th or 14th magnitude would be settled by directing that the images be 3″·75 diameter. Taking this as a basis we find that under best condition of sky a *white* 9th magnitude star is well impressed in 30 secs., but to get ordinary 9th magnitude stars under ordinary atmospheric conditions requires an exposure of 60 secs. Excluding all decidedly over exposed stars or stars of the red type (which upset every law yet formulated for this purpose), the diameters of the images are proportional to the square root of the times of the exposure.

From the measure of a great many stars it appears that to gain one photometric magnitude (light ratio 2·512) the time of exposure must be increased 3·16 times, or 10 times to gain 2 magnitudes; that is, if a 9th magnitude requires 60 secs. to give a measurable disc (3″·75) it will take 10 minutes' exposure to get a measurable disc of the 11th magnitude. Still, as I have already stated, it has been decided to expose plates destined for the catalogue (11th magnitude) only 5 or 6 minutes. This decision leads me to the belief either that discs which we find unsafe to measure are accepted as sufficient, or that our telescope has some optical constant which will have to be taken into account.

7.—ON THE DODGING TIDE OF SOUTH AUSTRALIA.

By R. W. CHAPMAN, *M.A.*, *B.C.E.*

8.—SOLAR PHENOMENA AND THEIR EFFECTS.

By HIS GRACE THE ARCHBISHOP OF HOBART.

9.—ON THE GROUPING OF STARS IN THE SOUTHERN PART OF THE MILKY WAY.

By H. C. RUSSELL, *F.R.S.*, *C.M.G.*

10.—REMARKS ON THE DESIRABILITY OF ESTABLISHING TIDAL OBSERVATIONS IN TASMANIA.

By R. L. J. ELLERY, *F.R.S.*, *C.M.G.*

11.—UNIFICATION OF STANDARD OF WEIGHTS AND MEASURES.

By R. B. LUCAS.

12.—A METHOD OF DETERMINING THE LONGITUDE AT SEA.

By Capt. J. SHORTT, *R.N.*

13.—THE SCIENCE OF THE UNSEEN.

Ven. Archdeacon HALES.

14.—A GRAPHIC METHOD OF SHEWING THE RELATION BETWEEN THE TEMPERATURE OF THE DEW-POINT AND TEMPERATURE OF THE AIR FOR ANY GIVEN CLIMATE.

By C. W. ADAMS.

Section B.

CHEMISTRY AND MINERALOGY.

President of the Section:
W. M. HAMLET, *F.I.C., F.C.S., Government Analyst of New South Wales.*

1.—THE OLEO-REFRACTOMETER IN ORGANIC ANALYSIS.

By W. M. HAMLET, *F.I.C., F.C.S.*

An optical method of chemical analysis, founded on the well-known fact of the refraction of light on entering transparent bodies at an oblique angle, has lately been devised by M. Ferdinand Jean, Director of the Municipal Laboratory in Paris, and improvements added by M. Amagat.

The law that the sine of the angle of incidence is in constant ratio with the sine of the angle of refraction gives the index of refraction, and as this differs in different media, it would appear that the specific refractive power of a substance is dependent on the chemical nature of the body examined.

The index of refraction is, as Ostwald has pointed out, the numerical value of the time required by light to pass through a given distance in the liquid under examination. Knowing, then, the time value for a standard of known composition, it follows that deviations from the normal refractive indices of compounds must indicate variation in their composition.

The oleo-refractometer has been found useful in the examination of butters, fats, oleomargarine, oils, naphthas, methylated spirits, and various other articles of commerce.

Dr. Muter first described this instrument in the *Analyst*,* and, being favourably impressed with the use of the instrument which I exhibit here before you, it may prove of interest to the members of this section of the Association.

The use of the refractometer being first applied to the examination of oils, it was called the oleo-refractometer by its original inventors, MM. Amagat and Jean.

Ellinger, Jour. Chem. Soc., LX., p. 1305, prefers to call

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* *Analyst*, Vol. XV., p. 87.

it a "difference-refractometer," and finds it available for obtaining the strength of solutions. A solution containing ·01 per cent. of a given salt causes a deflection of ·75 degrees, and a solution containing 1 per cent. causes the shadow to recede 7·5 degrees; a 2 per-cent. solution shows 15, &c.

2.—NOTE ON THE VOLATILITY OF MAGNESIUM.

By J. B. KIRKLAND, *F.C.S., Assistant Lecturer and Demonstrator of Chemistry, University of Melbourne.*

When the metal magnesium is heated to dull redness in a glass vessel in an atmosphere of dry hydrogen, the glass in contact with the magnesium becomes attacked, and covered with a brown film of reduced silicon. So far this is what one would expect from the powerful affinity of magnesium for oxygen. But the glass, at a considerable distance from the metal, also becomes covered with reduced silicon. The explanation of this phenomenon is not plain, for at a dull red heat the magnesium is not even fused, and we ordinarily suppose it requires a high temperature to volatilise it. How, then, can the glass be attacked at a distance? One theory to account for it was that the silicon just at the moment of its reduction unites with the hydrogen to form silicon hydride, and this being gaseous, volatilised, and decomposed in contact with the hot surface of the glass, depositing silicon and liberating hydrogen. This explanation did not meet the case, for when the magnesium was placed in a clean iron boat, so as to prevent contact with the glass, and heated, the latter was still attacked immediately above the magnesium. Another idea suggested itself—Has the hydrogen anything to do with it? Experiments were made using carbon-monoxide and sulphur dioxide, respectively, instead of hydrogen, and curiously enough the glass wasnot attacked, either in contact or away from the metal, but on raising the temperature to the softening point of glass both these gases were decomposed into their constituents, the magnesium taking the oxygen. Another experiment was made, placing the magnesium in a small iron boat, introduced into a tube made of clean sheet iron, this being placed in a tube of hard glass, and heated to dull redness in a current of dry hydrogen for some time. The iron tube was examined after being cooled, and the upper and distal end was covered with a

quantity of minute crystals of magnesium (?) : the metal in the boat had not fused. There are two ways we may possibly explain this apparent volatility of magnesium below its melting point—first, that magnesium heated in contact with hydrogen forms a volatile hydride, easily decomposable: second, that magnesium is considerably more volatile in hydrogen than in other gases, *i.e.*, carbon monoxide and sulphur dioxide. The first hypothesis seems to me the most plausible.

Another curious fact in this connection is the following. If a coil of magnesium ribbon (that used for lamps) be taken and gently squeezed in a vice or between the fingers, the metal emits a strong odour reminding one of phosphine. Yet the metal before the pressure has no smell.

3.—NOTE ON THE ELECTROLYSIS OF THE SALTS OF ORGANIC BASES.

By J. B. KIRKLAND, *F.C.S., Assistant Lecturer and Demonstrator of Chemistry, University of Melbourne.*

So far as I am aware, no attempt has hitherto been made to electrolyse the fused salts of organic bases. This is probably on account of their unstable character towards heat, the majority of them undergoing decomposition before fusion. However, I have at my command one that can be fused without decomposition, and, as it happens, from the powerful basic properties possessed by the radicle it contains, is one of great interest,—namely, tetraethylphosphonium iodide, $P(C_2H_5)_4I$; my object being to note whether the fused salt would be an electrolyte, and if so, the nature of the products of decomposition, and further, to try and discover if there was any chance of obtaining the free radicle $(PEt_4)_2$. A few grains of the salt was placed in a wide test tube, and closed with an india-rubber stopper, provided with two glass tubes for the passage of gas, also with two platinum electrodes long enough to touch the bottom of the tube. The air in the tube was displaced with dry hydrogen for some time, and the tube carefully heated in an air bath; the platinum electrodes were placed in circuit with a battery and tangent galvanometer.

While the salt remained solid no current passed, then just at the point of fusion 290° C. the galvanometer gave indica-

tions of current passing, then suddenly as the salt liquefied 290°-300° C. a violent effervescence took place.* At the positive electrode free iodine was liberated, and recognised by its colour, and after a little time oily globules made their appearance on the sides of the tube nearest the negative electrode; these proved, on opening the tube, to have the characteristic odour of triethylphosphine; powerful fuming also took place on the admission of air. The salt itself became of a dark red colour from the formation of polyiodide, by the combination of the free iodine with undecomposed salt.†

From the foregoing experiment the following facts are established:—(1.) That fused tetraethylphosphonium iodide is an excellent conductor and a good electrolyte. (2.) On electrolysis at 300° C. the salt splits up into triethylphosphine, butane (?), and free iodine. (3.) Apparently no chance of obtaining the free radicle by electrolysis.

In conclusion, there is no reason to doubt that all the salts of organic bases that can be obtained in the molten condition would be conductors and electrolytes.

4.—LECTURE EXPERIMENT ON GASEOUS DIFFUSION.

By J. B. KIRKLAND, *F.C.S., Assistant Lecturer and Demonstrator on Chemistry, University of Melbourne.*

An instructive lecture experiment on gaseous diffusion can be made in the following manner:—Take a piece of ordinary combustion tubing about 20 inches long; into this introduce a clean iron tube about 3 inches long and half an inch in diameter; close the ends with rubber stoppers having connecting tubes. The tube with its contents is next supported in such a manner that heat may be applied directly under the iron tube. The air in the tube is then displaced by slow current of dry hydrogen from a kipp, or other form of gas generator, making the gas travel in the direction of the empty part of the tube. (Note—the experiment is more striking if the iron tube is placed near hydrogen inlet). At the distal end the escaping gas is led

* The battery current had to be diminished.

† *See* Masson and Kirkland on the Salts of Tetraethylphosphonium. J. Chemical Society, Vol. LV., 1889.

into sulphuric acid. After allowing the gas to escape for some time, that portion of the tube in contact with the iron is carefully heated to dull redness. The iron should remain perfectly bright; if any colour similar to that produced when steel is tempered be visible at either end there is a leak somewhere, and must be stopped before continuing the experiment. Everything being secure and the iron free from colour, remove or loosen for one second or less the rubber stopper at the distal end of the combustion tube, replacing it gently but firmly in its place. After a few seconds you will notice a ring of colour on the bright iron gradually making its way along the cylinder to the front end of the tube. This colour we all know is due to the iron undergoing oxidation; but the curious part of the experiment just described is that the oxygen has travelled or diffused a considerable distance against a slow current of hydrogen in the opposite direction. After the colour has reached its maximum it gradually goes away, the oxide being reduced. The experiment may then be repeated. It teaches us a lesson on the care necessary in making connections in gaseous experiments.

5.—OCCURRENCE OF GALLIUM AND INDIUM IN A BLENDE FROM PEELWOOD, NEW SOUTH WALES.

By J. B. KIRKLAND, *F.C.S., Assistant Lecturer and Demonstrator of Chemistry, University of Melbourne.*

I desire to draw attention to the occurrence of two very rare elements—*e.g.*, Gallium and Indium—in a blende from Peelwood, New South Wales. It is the first time, so far as I am aware, they have been detected in any mineral in the Australian Colonies; indeed, the former has only been found in one or two places in the world, and is exceedingly rare. For some years past I have been engaged in the examination of the various minerals of the colonies—principally blendes—in order to detect the presence of the rarer elements, those particularly sought after being gallium, indium, and thallium. It is important from a chemical and mineralogical point of view that the localities where such rare metals occur should be known, as it is possible they may be found in quantity, or, again, be associated with new minerals

or even new elements. The task of analysing minerals on the chance of their containing rare substances is not a very enervating one. I have examined upwards of eighteen samples of zinc blendes and many samples of pyrites from various parts of the colonies, both chemically and spectroscopically, without success. However, a few months ago, while making an analysis and spectroscopic examination of a peculiar grey zinc ore from the place already mentioned, I was rewarded by a double: for by the spectroscope the characteristic line of gallium, *w.l.* 4170, was easily discernible, and the lines of indium, *w.l.* 4509, 4101, were faint but unmistakable. Since then I have, by operating on a larger quantity, succeeded in extracting a small quantity of the crude chlorides of gallium and indium, which from their properties leave no doubt that the mineral contains these elements. As to the percentage of gallium in the ore I am unable to state, but, judging from the ease with which it is detected, I should say it contains at least as much as the ore from Pierrefitte, in the Pyrenees, in which M. Lecocq de Boisbaudin discovered the element. (At present I am working up some kilos of the ore, and before this note appears in the Journal I hope to be in a position to definitely state the percentage of gallium.)

In conclusion, as it may be of some interest, I give the composition of the Peelwood ore :—

Analysis of the Ore from Peelwood, New South Wales.

SiO_2	6·05
Pb	16·71*
Fe	11·06
Cu	5·00
Zn	29·77
S	29·21
Loss and matters not estimated	2·30
	100·00

6.—THE ANALYSIS OF THE CAVENDISH BANANA *(MUSA CAVENDISHII)* IN RELATION TO ITS VALUE AS FOOD.

By W. M. DOHERTY, *Assistant Government Analyst, New South Wales.*

THE value of the banana as a perfect food has been frequently extolled, but so far as I can learn no analysis of the

* With 11 or 12 ozs. of Silver to the ton.

fruit has yet been published, and nothing is known of its food value beyond general practical experience. To supply a conspicuous gap on the list of fruits which have been submitted to investigation this analysis has been undertaken.

The Cavendish, or, as it is sometimes called, Fiji variety, has been selected because of its enormous consumption in Australia, where it has almost completely dislodged all the other kinds. This banana is the product of a plant which grows only to a height of about six feet, and it has therefore received the appellation "dwarf." Its original home was China, from which country it was brought to England by the Duke of Devonshire (hence the name Cavendish), and cultivated by him in the celebrated Chatsworth Gardens. From England it was brought to Fiji by a party of missionaries, thence finding its way to Australia. It is now grown to a considerable extent in Queensland, and will thrive well in the northern parts of New South Wales, especially in the Tweed River district.

The banana has been described as "the produce of one of the most splendid plants of the world. Underground there is a substantial root stock of long duration, from which rises stems, branchless, like those of palms, and carrying upon the summit half a dozen superb leaves of great size, of a rich lucid green, and which arch away from it on their long petioles, magnificently. The veining of the leaves is of a very rare and elegant kind, which has been fittingly called featherlike; innumerable lateral veins flowing from the midrib in a curvelinear manner, towards the margin. The stem is composed in reality of no more than the sheathing and closely compacted bases of the older petioles, in the heart of which, near the ground, the flower bud is generated. This in due time develops itself from among the youngest leaves as a huge pendulous raccine, constituted of crimson bracts, which protect innumerable though rather trifling flowers, followed again in due time by the well-known fruits—cylindrical, six or eight inches long, an inch or more in diameter, slightly curved, and when ripe pale yellow. The clusters of fruit are often four feet long, and weigh from twelve to sixty or eighty pounds. In the tropics it is said that two plants will grow anywhere—the castor oil and the banana. This is not only true, but it may be added with equal justice that no plant furnishes man spontaneously with supplies so vast of a pleasant and nourishing food. In countries where the mean heat of the year is never lower

than 75° F. the banana is the bread of the poor, and this all the year round, literally yielding fruit every month."

The analysis was made upon picked specimens, divested of the skin.

Composition in 100 *parts.*

Water	75·71
Albumenoids	1·71
Starch	5·90
Sugar	3·00
Carbonaceous matter (non-nitrogenous)	11·24
Woody fibre	1·74
Ash	0·71

Composition of the Ash.

Potash (K_2O)	55·10
Soda (No_2O)	12·00
Lime (CaO)	1·61
Magnesia (MgO)	5·41
Phosphoric Acid (P_2O_5)	7·70
Sulphuric Acid (SO_3)	1·80
Carbonic Acid (CO_2)	12·00
Chlorine (Cl)	1·10
Oxide of Iron (Fe_2O_3)	0·48
Silica (SiO_2)	1·96
Oxide of Manganese (MnO_2)	0·15
Loss, &c.	0·69
	100·00

Composition of the fruit, and percentage of mineral constituents, calculated dry :—

In 100 *parts.*

Albumenoids		7·05
Starch		24·78
Sugar		12·35
Carbonaceous matter (non-nitrogenous)		47·05
Woody Fibre		7·26
Potash (K_2O)	1·610	
Soda (Na_2O)	0·340	
Lime (CaO)	0·047	
Magnesia (MgO)	0·158	
Phosphoric Acid (P_2O_5)	0·224	
Sulphuric Acid (SO_3)	0·052	Ash, 2·92
Carbonic Acid (Co_2)	0·340	
Chlorine (Cl)	0·032	
Oxide of Iron (Fe_2O_3)	0·014	
Silica (SiO_2)	0·057	
Oxide of Manganese (MnO_2)	0·004	

From the small quantity of albumenoids or flesh-forming substances present in the banana, it cannot be considered by

itself a convenient food, or even sufficiently nutritious for all the requirements of man. Under normal condition the average man requires daily 4·2 ounces of albumenoids. To obtain this quantity from the banana fifteen pounds' weight of the fruit would have to be consumed—a quantity altogether excessive and decidedly inconvenient, containing no less than nine pints, or over a gallon, of water.

In nutritive properties the Cavendish banana bears a resemblance to the potato, as will be seen from the comparison following. It may be described as a very unevenly balanced food, not suited alone for the diet of man, but an excellent and wholesome addition to a diet rich in nitrogenous substances.

Comparison Analysis.

	Cavendish Banana.	Potato.
Water	75·71	75·77
Albumenoids	1·71	1·79
Total Carbonaceous matter (non-nitrogenous)	20·13	20·72
Other than Woody Fibre	1·74	0·75
Ash	0·71	0·97

7.—NOTE ON AN EXAMINATION OF WATER FROM LAKE CORANGAMITE, VICTORIA.

By A. W. CRAIG, *M.A., and* N. T. M. WILSMORE, *B. Sc.*

This examination was undertaken with the object of ascertaining the presence or otherwise of the rare alkalies, as, so far as we are aware, these have not yet been noticed in the mineral waters of the Australasian Colonies.

The sample was collected in a large demijohn, and with the usual precautions, by Dr. S. A. Ewing, of Cobden, in the Western District of Victoria, closed with a good cork, sealed, and forwarded to the University.

For various reasons it was not examined till about a month after collection, being kept in the meantime in a cool place in the laboratory.

Preliminary Examination.—On opening the vessel there was a strong smell of sulphuretted hydrogen, which was present in sufficient quantity to blacken lead paper. The

water was somewhat turbid when shaken, but the solid matter readily settled. Specific gravity of the water was 1·035. For the analysis the water was filtered, and the filtrate was clear and colourless. The reaction to litmus was distinctly alkaline. The quantitative examination of the water was made according to the methods described by Dittmar for the analysis of sea water.

The following is the result of the analysis :—

Calcium	0·063	parts per 1000
Magnesium	1·272	" "
Potassium	0·387	" "
Sodium	16·145	" "
Sulphuric acid (SO_4)	0·758	" "
Chlorine	27·312	" "
Bromine	0·102	" "
Sulphydric acid	—	
Carbonic acid	—	
Total bases as Sulphates	57·276	" "

The sulphuretted hydrogen and carbonic acid which were present in the water were not estimated, as, owing to the time which elapsed between the collection and examination of the sample, it was thought that the results would be of but little value.

The Examination for the rare Alkalies.—Four litres of the water acidified with hydrochloric acid were concentrated down in a porcelain basin. The crystals were collected fractionally and filtered hot in a steamer. They were allowed to cool slightly after the mother liquor had run through and again put in the steamer. In this way the crystals were more thoroughly and evenly washed than was possible by any other method. A mother-liquor of about 10 c.c. was finally obtained.

The process was repeated again as follows :—The second crop of crystals was dissolved in water and evaporated down till most of it crystallised out. The mother liquor was added to the third crop of crystals together with enough water to dissolve them, and again evaporated down to crystallisation, and so on. Finally, another mother liquor of about 20 c.c. was obtained and added to the first.

To this solution barium chloride was added in slight excess, and then enough barium hydrate to turn turmeric paper brown. The whole was then boiled for some time and filtered, and the excess of barium was removed from the filtrate with ammonium carbonate in the usual way.

It was then evaporated to dryness in a platinum basin, and

ignited to expel ammonium salts. The residue was taken up in a small amount of water, chloroplatinic acid was added in sufficient quantity to give a coloured solution with alcohol and ether, with which the precipitate was exhausted.

The residue was then washed by decantation with small quantities of cold water till there was only a small platinum precipitate left, which was then dried and ignited in a porcelain crucible. This, taken up with a drop of dilute hydrochloric acid and tested spectroscopically, gave the lines of potassium, sodium, and lithium. The alcohol and ether extract was evaporated to dryness in a porcelain crucible, ignited to decompose the platinic chloride as above, and with the spectroscope gave the lithium line strongly. The aqueous extract was also found to contain lithium. In no case was there any indication given of the presence of rubidium or cæsium.

8.—THE JARVISFIELD MINERAL WATER, PICTON, NEW SOUTH WALES.

By ALBERT J. SACH, *F.C.S.*

The town of Picton, New South Wales, was formerly known by the name Stone Quarry. It is situated in S. lat. 34° 10′, and E. long. 150° 44′, and is distant by rail 53 miles south-west from Sydney, on the Main Southern Road. The town contains a population of about 1000, and lies in a valley bordered by fertile hills, and is 500 feet above sea level. The land in the district is rich, and supports a large agricultural and dairy farming population.

The springs are situated on the old military grant (1822) of Jarvisfield, made to the late Major Antill, of H.M. 73rd Regiment. The land has continued in the ownership of the same family, and is now the property of John Macquarie Antill, Esq. The springs are about one mile from the Picton Railway Station, but are only 200 yards from the railway line.

The geology of Picton and neighbourhood may be described as consisting of alternations of Wianamatta shales and Hawkesbury sandstones, both of which are of Triassic age. The former constitute the agricultural surface and appear as ridge, hill, plain, or valley, as a consequence of

aerial denudation. The late Mr. C. S. Wilkinson, Government Geologist of New South Wales, estimates the Wianamatta series to be about 700 feet thick; they consist chiefly of argillaceous shales, and have evidently been formed in the quiet waters of a lake. At Picton valleys of erosion have cut through the entire thickness, exposing the underlying Hawkesbury sandstones. In a locality near Jarvisfield, the residence of Mr. Antill, I have proved the existence of quantities of calcium carbonate in the form of irregular concretions, also in a remarkable deposit known as Cone-in-cone structure. The underlying Hawkesbury sandstones are freely exposed in the creek beds and other eroded valleys, and they form the natural surface in the vicinity of the spring. A small stream, called the Picton or Stone-quarry Creek, partly encircles the town and empties itself into the Nepean River about two miles to the eastward. Soon after leaving the town the stream traverses a course near some perpendicular cliffs of Hawkesbury sandstone, which show a surface 55 feet high and 70 feet wide; the top of the cliff is level with the surface of the ground above. It is from the face of this cliff that the spring appears. The visitor stands amid the precipitous slopes, which are clothed with ferns, myrtles, and other Australian plants, and sees that from the top of the cliff downwards the rocks look perfectly dry, but from a projecting ledge the water appears oozing out of the horizontal joints and crevices and forms a quick succession of drops coming from a few score of points; some of the drops fall clear to the foot of the precipice, a distance of about 25 feet, while others fall on to the sandstones and gradually deposit a calcareous encrustation which covers many square yards of the sandstone surface. I have brought a few samples of this calcareous tufa, which often encloses leaves and twigs of the present vegetation; in some places this tufa is three or four feet thick, and hundreds of tons were blasted off and burnt for lime some forty years ago. The face of the cliff, and especially the wet part, has somewhat the appearance of the interior of limestone caves when covered with newly formed and wet calcite, but a closer examination proves it to consist of a gelatinous or glairy deposit which yields to the pressure of the hand. I have not had an opportunity as yet of examining this deposit chemically, but it, I believe, requires to be examined biologically, as deposits of the same appearance occur in connection with several of the springs of Europe, especially the thermal

ones; and this glairy substance is largely composed of varities of the diatomaceæ. The drops of water falling from the projecting cliff supply about 300 gallons in 24 hours; this supply is caught in a tank, so that all risk of surface contamination is avoided. The water as it issues from the cliff possesses the normal temperature. On parts of the cliff the tufa is quite dry and hard, and evidence is seen of former flows, or it may be the present spring has altered its place of exit from the underground channel. A chemical examination of the water caught direct from the drips gave the following results:—

Total solids per gallon, heated to 130° C., were 182·56 grains. These consist of—

Silica	·336	grains per gallon.
Iron, Alumina, or phosphates	traces	
Sulphate of Calcium	·67	
Bicarbonate of Calcium	17·83	
Ditto Magnesium	31·225	
Sulphate of Magnesium, with some chloride	11·13	
Chloride of Sodium, with a little potash	120·	
Nitrates, calculated as Nitrate of Sodium	·28	

The free ammonia and alluminoid ammonia amount to ·007 and ·008 grains per gallon respectively, showing the water to be practically pure. The water is free from poisonous metals. An examination for Lithia by wet processes gave negative results. Mr. Antill informs me that the volume of the spring remains about constant in all seasons and weathers, which fact points to a deep-seated origin, but I am inclined to believe that the spring is a result of an extensive system of surface drainage. The waters of the Stone Quarry Creek, which takes its origin in the hills of the Wianamatta shales, are decidedly brackish, and nodules of limestone may be detected on its upper slopes. It seems to me probable that a part of the surface water finds its way into the creek, and another part soaks into the soil till it reaches an impervious bed in the Hawkesbury sandstones, and this part finds its exit at the cliff mentioned above.

The Jarvisfield mineral water is becoming a recognised medicinal agent in Sydney. Several medical men have used it with success. Mr. Antill informs me that applications for

supplies from persons who have heard of its success are continually being received. I may be permitted to quote one instance of its successful use on a delicate little boy of wealthy parents resident in Sydney neighbourhood. The father, in writing to Mr. Antill, said, "I am certain your mineral water is exactly the thing he requires; before you were kind enough to send me the water he was very backward, in fact, I began to despair of his ever getting better, and had consulted no end of doctors about him, but they did him no good. . . I never saw him better than he is now, and he is beginning to grow fast." In two years the boy was quite well. The spring is situated within an easy distance of the capital of New South Wales; it is located in an interesting and beautiful district, and its particular site is one of romantic beauty. With these advantages I think it probable that the springs will become the resort of sufferers, and that in future days accommodation will be provided for those who wish to drink the waters.

I am not aware that that the Jarvisfield spring has been described before, but its comparative freedom from organic impurity has been lately attested by Wm. M. Hamlet, Esq., F.I.C., Government Analyst of New South Wales. I also learn that within the last few weeks the water has been analysed by the Mines Department of New South Wales. Angus Mackay, F.C.S., of Sydney, has also examined the water. The "Mineral Springs of Australia" forms the subject of a small pamphlet by Ludwig Bruck, but the Picton spring is not included. There are chalybeate springs at Mittagong, a few miles from Picton; but those of Jarvisfield may be said to possess cold, muriated, earthy waters.

9.—NOTE ON A "NATURAL BONE ASH" FROM NARRACOORTE, SOUTH AUSTRALIA.

By N. T. M. WILSMORE, *B. Sc., Melbourne University.*

THE sample of which an analysis is here given was collected by me in April, 1890, and has since been kept in a well-stoppered bottle. Recently it occurred to me that a short account of it might be of interest to members of this Section.

The name given above is somewhat a misnomer, as the substance is not derived from bones, but appears to be a decomposed guano, and in fact goes by that name in the

district. My reason for calling it Bone Ash will appear presently.

It occurs in what is known as the "Bat Cave," about seven miles from Narracoorte. This cave gets its name from the fact that a large number of bats are found in it, whereas the neighbouring caves, which, like it, are of the ordinary limestone formation, contain, so far as I am aware, neither bats nor guano.

The guano is found caked together, but is readily powdered up in the hand to a fine brownish-white amorphous powder.

On strongly heating it turns white, and does not char, even on heating with strong sulphuric acid.

Analysis gives	Per cent.
Moisture	17·51
Organic matter and combined water	7·01
Organic Nitrogen	0·00
Fe_2O_3	trace
MgO	0·07
CaO	36·89
Na_2O	0·27
NH_3	trace
SiO_2	0·28
CO_2	2·92
P_2O_5	32·69
SO_3	3·03
N_2O_5	0·50
	101·17

Or, combining Acids with Bases,—

Moisture	17·51
Organic Matter	4·59
Organic Nitrogen	0·00
$FePO_4$	trace
$Ca_3(PO_4)_2$	29·67
$CaHPO_4$	36·36
$CaSO_4$	5·15
$CaCO_3$	6·63
$MgHPO_4$	0·21
$NaNO_3$	0·77
NH_4NO_3	trace
SiO_2	0·28
	101·17

Owing to my being somewhat pressed for time, this analysis is not as accurate as I could wish. I am afraid the Calcium is too high and the Magnesium too low.

At present this substance is only used as a manure in the district in which it is found, but, as might be inferred from the almost complete absence of ammonia, with greatly varying success.

It has been tried for making cupels for silver assay in the Chemical Laboratory of the Melbourne University with very satisfactory results, the cupels having even a better surface than those made from the artificial material, hence the name given in the heading. This, together with its being sold for thirty shillings per ton at the cave's mouth, should recommend it to those who have much assaying to do.

I am told that similar deposits occur in various caves in the Western District of Victoria, but I have not seen any specimens myself.

10.—ANALYSES AND NOTES ON SOME OF THE MINERAL WATERS OF NEW SOUTH WALES.

By JOHN C. N. MINGAYE, *F.C.S., M.A.I.M.E., Analyst to the Department of Mines, Sydney.*

I. Water from a bore at Ballinore, Falbragar River, near Dubbo, N.S.W.

	Grains per gallon.	In 1000 parts.
Bicarbonate of Sodium	183·10	2·6157
" Potassium	12·83	·1833
" Lithium	·05	·0007
" Calcium	11·38	·1625
" Magnesium.........	9·36	·1337
" Strontium	trace	trace
" Iron	·70	·0100
Chloride of Sodium	6·92	·0988
Alumina	trace	trace
Silica	·28	·0040
Total fixed matter	224·62	3·2087

Free Ammonia .... 0·052 parts per 100,000
Organic, or Albumenoid Ammonia ·003 " "
Specific Gravity of Water at 65° F. = 1·00359
Trace of Phosphoric Acid present.

Remarks :—This water had a pleasant taste, and is highly charged with Carbonic Acid. The sample was struck while boring for coal, the

water rising from a depth of over 500 feet through a series of sandstones and shales.

II. Water from Spring at Rock Flat Creek, near Cooma, Monara District.

	Grains per gallon.	In 1000 parts.
Bicarbonate of Sodium	45·29	0·647
" Potassium	17·15	·245
" Lithium	*Nil.*	*Nil.*
" Calcium	52·08	·774
" Magnesium	22·40	·320
" Strontium	strong trace	strong trace
" Iron	*Nil.*	*Nil.*
Chloride of Sodium	5·04	·072
Nitrate of Soda	trace	trace
Silica	·56	·008
Alumina	trace	trace
Total fixed matter	142·52	2·036

Remarks :—Water highly charged with Carbonic Acid Gas. An excellent sample of table water.

Mr. Slee, F.G.S., Superintendent of Drills, in a Report to the Department of Mines,* states with regard to the Ballinore bore as follows :—"That at a depth of 540 feet the drill passed through a seam of coal 5 feet 2 inches thick, and while boring for a second seam of coal 10 feet below the first, artesian water commenced to flow to the surface, and is now flowing at the rate of 1000 gallons per hour, flowing through tubing 30 feet above the surface, and higher if required. The water when coming up through the bore-hole contains a great deal of gas, and has a taste somewhat similar to the German Seltzer water."

The Rock Flat Mineral Spring is situated about 10 miles to the S.E. of Cooma, and occurs in close proximity to the western banks of Rock Flat, in the Parish of Dangeling, County of Beresford. For a description of this spring and the geological formation of the surrounding district I refer you to a paper by Mr. Geological Surveyor Anderson, entitled "On the Mineral Spring at Rock Flat, near Cooma."

In a small book entitled "The Mineral Springs of Australia,"† edited by Ludivic Bruck, the information being reprinted from the "Australasian Medical Gazette" for

* Annual Report Department of Mines, 1886, p. 179.
† Records of the Geol. Survey of N.S. Wales, vol. I., Part III.

January, 1891, a description is given of the Ballinore water. Mr. Bruck compares it to the Vichy waters of France, and states it to be valuable for gout, gravel, catarrh of the bladder, diabetes, dyspepsia, also splenic and many other disorders.

These waters being strongly effervescent, due to carbonic acid gas, they may be described as carbonated mineral waters, and when placed in suitable bottles, or stored in syphon drums, should command a ready sale as table waters.

The spring at Cooma is held under lease from the Government by the Australian Natural Mineral Water Company, at an annual rental of £20, the water being retailed by them at per drum or three-pence per glass.

III. Mineral Water, said to possess medicinal properties, from Jarvisville, near Picton, New South Wales:—

	Grains per gallon.	In 1000 parts.
Total fixed matter dried at 220° F...	197·480	2·8201

ANALYSIS.

	Grains per gallon.	In 1000 parts.
Lime (CaO)	7·504	·1072
Magnesia (MgO)	24·842	·3548
Silica and Silicates	·812	·0116
Oxide of Iron (FeO)	trace	trace
Alumina (Al_2O_3)	ditto	ditto
Soda (Na_2O)	53·320	·7617
Potash (K_2O)	6·576	·0939
Sulphuric Acid (SO_3)	6·757	·0965
Carbonic Acid (CO_2)	15·820	·2260
Phosphoric Acid (P_2O_5)	trace	trace
Chlorine (Cl)	80·600	1·1514
Organic matter	trace	trace
Total fixed matter	196·231	2·8031

Free Ammonia	trace	per 100,000 parts.
Organic or Albumenoid Ammonia	·012	,,
Oxygen absorbed in 15 minutes	·0196	,,
Ditto, ditto, 4 hours	·0640	,,
Nitrogen as Nitrates	trace	
Ditto as Nitrites	trace	
Reaction with litmus-paper		Alkaline
Taste		Saline
Odour when heated to 40° C		Earthy
Colour when viewed through 2 ft. standard tube		Pale Green
Poisonous metals		*Nil.*

Remarks:—This water may be classed as a mineral water, and probably may possess some medicinal properties.

11.—ANALYSES OF DISCHARGED STORAGE BATTERY PLATES.

By A. HENRICK JACKSON, *B.Sc., F.C.S., &c., Professor of Chemistry at the Veterinary College, and Science Lecturer at the Grammar School, Melbourne.*

THE positive plate of a storage battery is said to be filled with a paste of Sulphuric Acid, and either Red Lead or Litharge. The negative plate is filled with a paste of Sulphuric Acid and either Litharge or a mixture of Litharge and Lead Sulphate.

During the process of charging the filling of the positive plate is nearly all changed into Peroxide of Lead; whilst that of the negative plate is changed to metallic Lead. It is regarded that the energy given out by the cell is due to the change into Lead Sulphate of the Peroxide of the positive plate, and of the metallic Lead on the negative plate during discharge.

Some plates having come into my hands for other purposes than those of this paper, I thought it would be interesting to determine the composition of the filling, and also to use them as a means of comparing several different methods of analysis. Some of the methods will be seen, from the results appended, to be unreliable for the analyses of the mixtures as they are present in these plates.

ANALYSES OF THE POSITIVE PLATE FILLING.

Determination of Peroxide.

1. I took 17·939 grammes of the finely-powdered plum-coloured filling, and treated it with Hydrochloric Acid. Chlorine was given off, and received in an aqueous solution of Potassium Iodide. The Iodine thus set free was titrated by a standard solution of Sodium Thiosulphate, of which 508c.c. were required to decolourize it. This 508c.c. = 550c.c. standard, Iodine solution = 1·95 grammes, Chlorine = 6·57 g., Peroxide = 36·62 per cent.

2. I took 8·202 g.: it required 246·77cc. of Thiosulphate = 25·2c.c., Iodine = 3·176 g., Iodine = ·887 g., Chlorine = 2·985 grammes, Peroxide = 36·39 per cent.

3. I took 6·684 g.: it required 200c.c. of Thiosulphate = 205c.c., Iodine 2·45 g., Peroxide = 36·65 per cent.

4. I sifted 1·297 g. into 30c.c. of glacial Acetic Acid and digested it on the outside of a water oven for three-quarters of an hour, filtered, washed with the acid, and then with

water, dried, and weighed. It had not lost weight; the filtrate did not contain any Lead; yet this is a method given for testing Red Lead for Lead.

The mean determinations 1, 2, and 3 may be taken as correct—

$$\left.\begin{matrix}36{\cdot}62\\36{\cdot}39\\36{\cdot}65\end{matrix}\right\}=36{\cdot}55$$ per cent. Peroxide, corresponding to 31·66 per cent. Lead.

Determination of Sulphate.

1. I took 5·785 g., boiled it in water with 10 g. of Sodium Bicarbonate, digested for some hours, and filtered it. I took half the filtrate, acidulated it with Nitric Acid, boiled it with Barium Nitrate; allowed the Barium Sulphate precipitate to subside, filtered, washed, dried, ignited, cooled, and weighed 1·451 g., less ash ·003 = 1·448 g.; double this = 2·896 g. Barium Sulphate, corresponding to 1·193 g. SO_4; deduct ·016 g. SO_4, for the Sulphate in the 10 g. Sodium Bicarbonate, and it leaves 1·177 g. SO_4 = 20·34 per cent. SO_4, or corresponds to 64·19 per cent. $PbSO_4$, or to 43·85 per cent. Pb.

2. The Acetates of Ammonium and Sodium are used for dissolving out Lead Sulphate in mixtures. Their value is lessened by their power of dissolving some Oxide of Lead; however, I found the method to be fairly accurate in this case.

I took 3·5805 g. and digested it with a solution of Sodium Acetate, boiled, and filtered. To the filtrate I added a little Sulphuric Acid, let it stand for some hours, filtered, washed the precipate of Lead Sulphate, dried and weighed it, 2·347 g. = 65·54 per cent. Lead Sulphate.

The undissolved residue of Peroxide was washed, dried, and weighed, 1·134 g., whereas it should have weighed 3·5805 − 2·347 = 1·2335 g. There was thus a loss of ·0995 g. of Peroxide, or probably a little more, which would account for the percentage of Lead Sulphate being slightly higher than in the first determination.

3. I fused a weighed quantity with some Sodium Bicarbonate in a crucible, and poured the fluid mass into water, boiled for a long time, and estimated as $BaSO_4$, but only got 13 per cent. SO_4. I regard the failure as due to the very slow solubility of the fused mass in water.

4. I took 1·345 g. and macerated it in successive portions of a cold saturated solution of Sodium Chloride during a week. The residue was finally washed, dried, and weighed, = 1 g.; showing that only ·345 g. had been dissolved by the

salt solution, which would only indicate 25·6 per cent. Lead Sulphate, so that this method was a failure.

Determination of Lead.

1. I took 1·171 g., dissolved it in dilute Nitric Acid with the aid of some methylated spirit (therefore either reduced by aldehyde formed and dissolved as nitrate, or dissolved with the Acetic Acid formed by oxidation of the spirit). After addition of Sulphuric Acid I let it stand a couple of days; then filtered, washed the Lead Sulphate with weak spirit, dried, ignited, cooled, weighed 1·273 = ·87 Pb. = 74·29 per cent. Lead.

2. I took 1·345 g., and treated with Sodium Chloride solution, as mentioned (detn. 4 of sulphate); the residue was dissolved in Hydrochloric Acid and added to the solution; the whole was then nearly neutralised by Caustic Soda, warmed, and a current of Sulphuretted Hydrogen passed through until the Lead Sulphide was precipitated. The precipitate was washed, dried, weighed by counterpoising with another filter = 1·18 g., Lead Sulphide = 1·022, or 75·91 per cent. Lead.

3. I took 7·37 g., and fused it with Potassium Cyanide. There was a brick-red slag, and a clean button of Lead, which weighed 4·97 g., or 67·4 per cent. Lead, which is obviously too low.

The mean of determinations 1 and 2 may be taken as correct, more especially as they agree with the results of the Peroxide and Sulphate determinations.

No. 1,	74·29	Peroxide, 36·55 =	31·66 per cent. Pb.
No. 2,	75·91	Sulphate, 20·34 =	43·85 per cent. Pb.
Mean,	75·1 p.c. total Lead	Total......	75·51 per cent. Pb.

Result.

The filling of the discharged positive plate consisted of—

Peroxide of Lead	36·55 per cent.
Sulphate of Lead	64·19 per cent.
	100·74

Analyses of the Negative Plate-filling.

Determination of Sulphate.

1. I took 6·012 g. of the finely-powdered, bluish-slate-coloured filling, and boiled it with an aqueous solution of

10 g. of Sodium Bicarbonate, filtered and washed. I acidulated half the filtrate with Nitric Acid, boiled with a solution of Barium Nitrate, allowed the white precipitate of $BaSO_4$ to subside; then filtered, washed, dried the precipitate, ignited it, cooled, and weighed 2·211 g., less ash ·033 = 2·208 g.; double this = 4·416 g., deduct ·038 g. as the equivalent of the Sulphate in the $NaHCO_3$ used, and there is left 4·378 g. $BaSO_4$ = 72·82 per cent. Barium Sulphate = 30 per cent. SO_4, corresponding to 94·68 per cent. of Lead Sulphate.

2. I took 1·644g., dissolved it in 5c.c. of hot Hydrochloric Acid, diluted with water, allowed it to stand for the Lead Sulphate to subside, filtered, washed with weak spirit, dried, ignited, cooled, and weighed 1·584 g., less ash ·003 g. = 1·581 g.; deduct ·04 g. for the Sulphuric Acid in the so-called pure Hydrochloric Acid, and there is left 1·541 g., or 93·73 per cent. of Lead Sulphate.

3. I fused a weighed quantity with Sodium Bicarbonate in a crucible; then broke up the crucible, and boiled for a long time in water. It evidently did not all dissolve, as I only found about 21 per cent. SO_4 after precipitating with a Barium salt. The method of merely boiling with water and the alkaline carbonate is evidently much preferable to that of fusion.

4. I took 2·353 g. and macerated it in successive portions of a cold saturated solution of Sodium Chloride for a week. The residue, after washing and drying, weighed ·333 g.; hence 85·85 per cent. of Lead Sulphate had gone into solution. This is a much better result than the similar experiment with the positive filling, and seems to point to the physical state of aggregation of the particles as the determining cause of the difference in solubility. Probably a freshly precipitated Lead Sulphate would be entirely soluble, but the method is too unreliable for use with old samples such as these.

I also used these Sodium Chloride solutions for determining the Sulphates with Barium Chloride in both plates; but the results were wrong, and I found the error to be due to the presence of Sulphate in the so-called pure Sodium Chloride.

The mean of the first two determinations was—

No. 1, 94·68
No. 2, 93·73

Mean, 94·2 per cent. $PbSO_4$, corresponding to 64·35 per cent. Lead.

Determination of the Lead.

1. I took 707 g.; it dissolved easily in dilute Nitric Acid; after addition of Sulphuric Acid and Methylated Spirit it was allowed to stand a couple of days, then filtered, washed with weak spirit, dried, ignited, cooled, weighed ·738 less ash ·003 = ·735 g. Lead Sulphate = ·502 g. Pb = 71 per cent. Lead.

2. I took 1·442 g. and boiled it in an aqueous solution of Potassium Hydrate until dissolved, then I added excess of dilute Sulphuric Acid, let stand, filtered, washed and dried, ignited and cooled, weighed 1·47 g. $PbSO_4$ = 1·003 g. Pb, corresponding to 69·55 per cent. of Lead.

3. I fused 23·328 g. with Sodium Bicarbonate, Potassium Cyanide, Sodium Chloride, and an iron nail; there was a clean button of Lead weighing 15·525 g., or 66·5 per cent. Lead. This result, although better than in a similar experiment with the positive filling, is still too low. Perhaps it was due to the temperature of the furnace being too high, or the crucible kept in it too long a time so that some Lead was volatilized. I suppose that the Iron would prevent any Sulphide of Lead—that might have been formed—from being held by Alkaline Sulphides in the slag.

The mean of the first two determinations is—

No. 1	71·00
No. 2	69·55
Mean	70·25 per cent. of Lead.

As the total Lead is 70·25 per cent., and there was 94·2 per cent of Sulphate of Lead, which would contain 64·35 per cent. of Lead, it follows that there would be 5·9 per cent. of Lead in the free state.

Result.

The filling of the discharged negative plate consists of—

Sulphate of Lead	94·2 per cent.
Metallic Lead	5·9 per cent.
	100·1

12.—MINERALS OF EASTERN GIPPSLAND.

By DONALD CLARK, B.C.E., *Director North Gippsland School of Mines.*

! After a mineral denotes that it is rare.
!! That it is common.
!!! That it is in workable quantity.

ALMOST the whole of the following minerals have been examined by me; a few I take from a Report of Mr. Howitt's.

I am aware that many of these enumerated have been described before by the Mining Department, Victoria, but to leave these out would be to present an incomplete list.

As might be expected, most minerals were sent in owing to their supposed commercial value, so that the list is on the side of metallic substances.

Certain districts within my prescribed area have not been touched, but I trust to complete the enumeration of these places in future.

I am specially indebted to Messrs. Jorgensen (Bairnsdale), A. L. Campbell, C.E. (Omeo), Sidney Horsley, M.C.E. (Bruthen), for the pains they have taken to collect specimens and give information.

Amphibole (Hornblenbe).—In igneous rocks, Dargo !!.

Anglesite.—Buchan ! From oxidised galenite.

Arsenopyrite.—Boggy Creek !!, Deptford !!!, Omeo !!!, Baldhill Creek !!!, Dargo !!!, Wombat Creek !!!, Haunted Stream !!!, and other goldfields.

Apatite.—Bruthen Creek !, Dargo basalts, Tabberraberra !. (H.)

Azurite.—Buchan !!, Wombat Creek !!.

Barite.—As crystals in vesicular ferro-manganese ore, Boggy Creek !, Buchan !!!, enclosing lode material.

Biniteé.—Wombat Creek !, with other ores of copper.

Biotite.—Mount Taylor quartz porphyries !, sparingly; also at Marengo Creek !.

Bismuth.—Wombat Creek !!!. Pieces up to one pound weight have been obtained. In some free gold is visible.

Bismuthinite.—Lode at Wombat Creek !!. Bald-hill Creek !, auriferous.

Bornite.—Buchan, ! with chalcopyrite.

Calcite.—Buchan!!!. In crystallized veins in limestone; also stalactitic in caves. Clear radiating crystals can be obtained. Wombat Creek!!!, associated with galenite. Limestone caves at Bindi!!!. As marble, Bindi!!!. Several fossils at Bairnsdale in Tertiary limestone crystallize, in rhombohedrons, as the *Clypeaster gippslandicus*; in spiral groups of curved crystals in hollows left by dissolved fossils. As dog-tooth spar on dissolved hinges of spondylus. As hydraulic limestone, Bairnsdale!!!, Nicholson!!!, Tambo!!!.

Cassiterite.—Mount Taylor Creek!!, with ragged gold, crystals, black and grey. In heads of some creeks flowing into Mitchell River!!, Bruthen!!, Mount Wills!!!. In dykes consisting of porphyritic felspar and quartz, sometimes with mica or tourmaline. Where felspar is very abundant the dyke has decomposed and may be shovelled out. Lumps of oxide up to one hundred-weight have been obtained, yielding 73 per cent. metallic tin. Lodes occur every few hundred yards over many square miles. Country—metamorphic schists, bounded by granite and penetrated by porphyry.

Cerussite.—Buchan!!, Wombat Creek!!, Dargo!, Snowy River!.

Chalcocite.—Wombat Creek!.

Chalcopyrite.—Bruthen!, Buchan!!!, Deptford!!, Omeo!!, Wombat Creek!!!.

Chlorite.—Mount Taylor porphyries!.

Chrome Ochre.—Buchan!.

Chrysocolla.—Omeo!.

Chrysolite.—Mitchell River!; in gravels. Snowy Bluff!. (H.)

Coal.—Mitchell River Weir. In small seam, just reported.?

Copper.—On branch of Wentworth River!.

Covellite.—Crooked River!.

Electrum.—Swift's Creek, Omeo!!. (H.)

Erythrite.—Dargo!!. In quartz in bunches, crystals peach-coloured and cleavable; ore rich in gold where it occurs.

Fibrolite.—Crooked River.!

Franklinite.—In black sand, Tambo and Nicholson Rivers.!

Galenite.—Wombat Creek!!!, crystallized and massive, along with ores of copper; silver, 30 oz. per ton. Buchan, crystallized and granular; silver, 25 oz. per ton. Swift's Creek!!, in gold mines; silver, 100 oz. per ton. Haunted Stream!!, Dargo Comet Mine!!, auriferous.

Garnet (Almandite).—Rolled pebbles, with gold, Livingstone Creek!!!. Mount Taylor!!. In porphyritic rock as small dodecahedrons; also in heads of creeks from Mount Taylor, with Menaccanite.

Glauconite.—Bruthen!. In cavities near quartz walls, Snowy River Bluff (H.)

Gold.—Alluvial. Mainly in heads of creeks, their beds and terraces in almost every creek and river in North Gippsland. In leads underlying basalt. Dargo!!!. In reefs. Most permanent near contact with granite. Places too numerous to mention. None of the mines were ever worked to a great depth (over 400 feet), owing to influx of water, and mineralized stone. Many of the mines have given continuous yields of several ounces to the ton, but, with the exception of those near Omeo, Bendoc, and Clarkeville, few are in working order. In many, surface honey-combed quartz, stained with ferruginous material, gives a return of several ounces per ton; but as the stone is undecomposed beneath water level, the amount of gold won rapidly diminishes.

Graphite.—Mount Wills!!!.

Hematite.—Nowa Nowa!!!. In lode, intermixed with a little silica. Free from phosphorus and sulphur. Mount Taylor!!, columnar. In rolled masses, Livingstone Creek!.

Red Ochre.—Omeo!!, Boggy Creek!, Wombat Creek!!.

Hyalite.—Gelantipy!!!, Mitchell River Gravels!, Omeo!.

Jamesonite.—Dargo!, Murrendal!!.

Leucopyrite.—Deptford!!, Mount Baldhead!!, Dargo!!!, Omeo!!, Wombat Creek!!!. Most specimens auriferous, some argentiferous.

Lignite.—Between Bairnsdale and Mount Look-out. Of Pliocene or Post-Pliocene age!!. Stratford!.

Limonite.—Nicholson River!!!. In massive lode. Clifton Creek!!, Boggy Creek!!, Bairnsdale!!, Buchan!!, Omeo!!!.

Magnetite.—Nowa Nowa!!. In Dargo, basalts (H.)

Malachite.—Buchan!!, on surface quartz. Dargo!.

Manganite.—Mount Taylor!!.

Marcasite.—Wombat Creek!!, Omeo!.

Melaconite.—Wombat Creek!. In small lumps.

Menaccanite.—In black sand of alluvial beds of Tambo and Nicholson!!. Creeks flowing from Mount Taylor!!!.

Muscovite.—Mount Wills, in dykes!!. Some flakes measure 3″ × 2″; also in most of the older granites of North Gippsland.

Opal.—Gelantipy!!!. In large deposit; occasional pieces show a play of colours; most are yellowish or dark brown.

Orpiment.—Occurs in cavities in pyritic quartz, with Realgar; Mount Baldhead!, Deptford!.

Orthoclase.—Mount Taylor!!. Large and well-defined crystal occur in same series of rocks throughout North Gippsland.

Pharmacosiderite.—Boggy Creek, near Mount Taylor, *cubic* green crystals, in crevices of greenish-stained quartz, containing gold.

Pretinite.—Snowy Bluff (H.)

Psilomelane.—Mount Taylor District!!!. In veins intermixed with quartz. Many fragments of quartz are covered with a film of steel gray mineral. Bruthen!!, Boggy Creek!!, Omeo!!, Gelantipy!!.

Pyrites.—Occurs in nearly all the gold-bearing reefs in the district, along with leuco-pyrite, arseno-pyrite, in some cases giving 40 ounces of gold to the ton. Haunted Stream!!! and Omeo!!!, Dargo!!!. Carpenter's Quarries, Nicholson River!, one-inch cubes have been obtained.

Mount Look-out!, nodular masses in lignite. Clifton Morass!, pseudomorph after wood.

Pyrolusite.—Mount Taylor!!.

Quartz.—The most plentiful mineral in the district. In veins on all the goldfields.

Agate!.—In rolled lumps, Boggy Creek; crystals of quartz interlaced, with gold enclosed, Baldhill Creek.!

Rock Crystal.—Nicholson River!.

Jasper, Chalcedony, and other varieties near Buchan!!!.

Bronze-coloured Quartz.—Mount Taylor!!. Sometimes shows an iridescent film, which consists of ferric-oxide.

Quicksilver.—From an upper tributary (Swamp Creek) of the Wentworth, in alluvial!. (Jorgensen.)

Realgar.—See Orpiment.

Sapphire.—Bairnsdale gravels!, Upper Boggy Creek gravels!.

Serpentine.—Dargo!!.

Siderite.—Bruthen Creek!!, Gelantipy!!, Mount Taylor!!!. In satin-coloured masses, with patches of manganese-oxide, in places dark coloured and changed to limonite.

Silver.—Omeo!.

Sphalerite.—Boggy Creek!. Black in quartz, with gold, Haunted Stream!, Buchan!!. In small veins, with metallic lustre, Omeo!!.

Stibnite.—Bendoc!!, Dargo!!, auriferous Buchan!!, argentiferous; Swamp Creek!, auriferous.

Sulphur.—In cavities from decomposed pyrites!, deposited through oxidation of sulphuretted hydrogen evolved at Clifton Morass!; Nicholson River, at Sarsfield, where mounds six feet high have been thrown up and free sulphur deposited in the crater-like basin.

Topaz.—Crooked River.

Tourmaline.—Bruthen!, greenish radiating crystals. Bemm River!, Mount Wills!!. Some dykes are studded with black hexagonal crystals, mica often being absent where it occurs. Some crystals are plainly cleavable (almost lamellar) parallel to the larger axis.

Vivianite.—Sarsfield!. (H.)

Wad.—Boggy Creek!!!, Merrigig Creek!!!; associated with quartz lodes in that district.

Asbolite.—Boggy Creek!!!, Mount Taylor!!, Dargo!!!. Occurs earthy; also in concretionary mamillary masses; sometimes laminated and hard, enclosing white clayey material.

Lampadite.—Black earthy masses. Wombat Creek.

Zeolites.—Gelantipy.

13.—NOTES ON THE EXUDATIONS YIELDED BY SOME AUSTRALIAN SPECIES OF PITTOSPORUM.

By J. H. MAIDEN, *Curator of the Technological Museum, Sydney.*

The word *Pittosporum* is derived from *pitto*, pitch, and *spora*, seed, and has reference to the sticky substance round the seeds.

Lindley (*The Vegetable Kingdom*), pointing out that the bark of *Pittosporum Tobira* has a resinous smell, observes that this resinous quality seems general in the Order; nevertheless, I am not aware that the nature of the resinous bodies to be found either in the important genus *Pittosporum* or in the Natural Order Pittosporeæ has been enquired into, and

even the allusions to them in Botanical literature appear to be but few.

The Black Mapau *(P. tenuifolium)* and White Mapau *(P. eugenioides)* yield a gum-resin, but not in quantity to make it valuable. *(Rep. N.Z. Exh.* 1865*)*.

The resinous exudation afforded by the bark of *P. eugenioides* was formerly used by the Maoris to perfume oil; the leaves and flowers are bruised and mixed with fat to anoint their bodies. (Kirk, *Forest Flora of N.Z.)*

Pittosporum floribundum, W. et A., of Western India, closely allied to if not identical with *P. undulatum*, yields "an aromatic yellow resin or oleo-resin having very tenacious properties." *(Pharmacographica indica.)*

The above passages obviously refer to resins or gum-resins. The following two species are, it will be observed, stated to yield gums.

GUMS.

A. *Pittosporum phillyrœoides*, D. C., (Syn. *P. acacioides*, A. Cunn.,) "Native Willow," &c., an interior species.

Found in all the Colonies except Tasmania.

This small tree is stated to yield a soluble gum. See the following:—

(1.) "In transparency and solubility it (Acacia gum) is surpassed by the gum of *Pittosporum acacioides* and other *Pittosporums.* Mueller *(Technologist,* ii., 120; adapted from *Official Catalogue, Victorian Exhibition,* 1861.*)*

(2.) "This tree yields a gum somewhat similar to gum arabic." Mueller *(Cat. Timbers, Technological Museum, Melbourne.)*

This species is also probably referred to in the following passage:—"The gums exuded by the wattles and a Pittosporum were also used as food." *(Aboriginals of Victoria,* Brough Smyth, I., 209.*)*

B. *Pittosporum bicolor*, Hook. This tree is said to yield a pale useful gum. (Mueller in *Cat. Timbers in Tech. Museum, Melbourne.)*

Anticipating a little, I may observe that all the Australian *Pittosporum* exudations which I have met with are gum-resins, and gum-resins of an interesting type. I have not had the good fortune to meet with true gum on a *Pittosporum*, and I should like very much to see such a substance from

this source. It will be observed that I do not impugn the accuracy of those who state that a gum can be found in this genus, for I am fully aware that a gum, and a gum-resin or a resin, may indubitably occur in the same genus, *e.g.*, *Grevillea*, *Xanthorrhœa*, *Cedrela*, *Calophylla*, *Terminalia*, &c.

The exudations I have been fortunate to obtain fall under three species, *P. bicolor*, *P. undulatum*, and *P. rhombifolium*. These substances do not freely exude, and I have not obtained them in abundance, but in quantity quite sufficient to enable me to state their characteristics and composition. I describe them in detail.

Gum-Resins.

Pittosporum bicolor, Hook: B. Fl. i. 113.

Found in Tasmania, Victoria, and New South Wales. "Whitewood," "Cheesewood."

The exudation from this species experimented on by me was obtained from the Delegate District, near the Victorian-New South Wales border, and has a most sickly smell, which soon causes nausea and headache. It is of a greasy lustre, of a dark orange colour, and is in irregular fragments for the most part of the size of peas; it looks like cracklings. It is fairly tough when fresh. It causes paper to have a greasy appearance when pressed upon it. It does not stick to the teeth, but tastes like rancid fat.

Very little of this substance appears to be found on trees growing in what may be called "jungle" ("brush" is the Colonial word), where they grow best, but on rocky ridges and stony sides of mountains (? in uncongenial surroundings), where they are rather stunted, it is much more plentiful. The fruit is also coated with much resin, and trees on the ridges are sometimes heavily laden with fruit. This is another proof of what appears to be true as a general rule, viz., that perfectly healthy, unwounded trees do not yield gum or resin. It seems that this species yields a more plentiful exudation than does *P. undulatum*.

1. Examination of the Gum-Resin as collected.

When the original exudation is treated with solvents, only a portion goes into solution, the external portions of the lumps being very insoluble, having hardened by drying, owing to the evaporation of the essential oil contained in the original gum-resin.

The subtance was treated successively with light petroleum, ether, alcohol (sp. gr. ·834), water, soda solution (·2 per cent.), and hydrochloric acid, with the following results:—

Light petroleum dissolved 17·63 per cent. of a pale resin after 8 days, together with essential oil.

Ether, after 8 days, extracted 13·379 per cent. of a yellow resin, which retained a trace of the characteristic odour of the essential oil to which the odour of the gum-resin is due.

Alcohol dissolved 4·109 per cent. of a yellow resin.

Water dissolves 1·38 per cent.; the soluble matter is precipitable by alcohol, and proves to be arabin.

On treatment with soda solution the liquid deepens in colour to a dark yellow, and 19·575 per cent. is dissolved; from this 1·642 per cent. is precipitated by alcohol, and is metarabin, the remainder (17·933 per cent.) being a resin soluble in the alkaline solution.

Hydrochloric acid has but the slightest action upon the residue, or in fact upon the original gum-resin.

The residue was principally insoluble gum or mucilage, together with insoluble resin, the total amount being 41·42 per cent.; the percentage of ash made by direct estimation was ·469.

These amounts give a total of 97·493 per cent., leaving (by difference) 2·507 per cent. of volatile oil, and this determination was confirmed by estimations of oil contained in two separate sixths of the light petroleum solution.

Summary.

Resin soluble in light petroleum	17·63
" " ether	13·379
" " alcohol	4·109
Arabin	1·380
Resin and colouring matter soluble in soda	17·933
Metarabin	1·642
Essential oil	2·507
Residue (insoluble mucilage, resin, and impurities)	41·420
	100·000

2. Examination of the soft inner portion of the Gum-Resin.

The dried external portion of the gum-resin is very insoluble in all solvents, and experiments with it are not entirely satisfactory. I therefore removed this outer portion,

and experimented with the inner viscid portion, which is of a homogeneous nature, and of approximately constant composition.

This soft interior portion was digested in ether, which removed 60·09 per cent. of resin and oil, of which 6·29 per cent. was a volatile oil.

The residue was then treated with alcohol (·834 sp. gr.), when 1·544 per cent. of resin was dissolved out—orange-yellow in colour like that removed by ether.

The remainder consisted of gum, which is almost insoluble in water, even on boiling, but which swells up very much in that liquid. Its percentage was 37·29, of which ·467 was ash.

Summary.

Resin soluble in ether	53·8
Volatile oil	6·29
Resin soluble in alcohol but insoluble in ether	1·544
Gum (metarabin) + trace of impurity	36·823
Ash	·467
Loss	1·076
	100·000

The above analysis is to be taken as giving the true composition of the exudation of ***Pittosporum bicolor***.

The appearance of the gum-resin would indicate that it contains a fixed oil, but such a substance is not present. If gently pressed on paper, the gum-resin greases it in a manner strongly resembling the stain of a fixed oil, but more careful examination shows that this stain is owing to the pasty solution of resin in essential oil about to be referred to.

The oil associated with the resin evidently dissolves a portion of the resin, and is in solution with it. It is driven off with difficulty, and *not* entirely until water has been previously added. The resin does not darken much during this process of driving off the essential oil.

In order to obtain the essential oil, water is added to the gum-resin to emulsify it. The mixture is then rubbed up and distilled at 110° C. by means of an air-bath. It is to this volatile oil that the unpleasant odour of the gum-resin is due.

The gum is difficultly soluble in caustic soda. The portion dissolved is precipitated by alcohol, and answers to the tests for arabin, showing the original gum to have been in the form of metarabin. Acid solutions have no effect on the gum-resin.

The exudation of *P. bicolor* is, therefore, a gum-resin whose resin holds an essential oil incorporated with it, and its composition is analogous to that of myrrh, which likewise contains about 40 per cent. of gum.

It will be convenient to institute a brief comparison between the gum-resins of *P. bicolor* and *P. undulatum* after the latter has been dealt with.

Pittosporum undulatum, Vent.: "Cheesewood."

Found in all the Colonies except South and Western Australia.

It appears that trees of this species require to be injured, as sound, uninjured trees have not been observed to yield gum-resin. This species is very liable to be attacked by borers, which cause an exudation of resin, but even in sound trees the fruits are sticky from presence of gum-resin. This substance has a powerful and, to my mind, if not too abundant (when it is apt to create nausea), a delicious odour of a turpentiny character, which somewhat resembles that of oil of cubebs, but it is quite *per se.* In the mouth it sticks to the teeth, softening very readily. It tastes powerfully aromatic, and slightly burns the tongue. It is of an amber colour when freshly exuded, but darkens with age. It is more or less liquid.

A correspondent stated that, having a dog badly wounded, he applied this resin, "on account of its aromatic smell," when the wound healed "with amazing quickness in a few days."

2·518 grams of the exudation from *P. undulatum* taken and digested in light petroleum for eight days, when 42·960 per cent. of resin and essential oil were dissolved out. The solution was heated in an air bath at 110° C., till a constant weight was obtained, when 7·599 per cent. of esssential oil was driven off. The remaining resin (35·361 %) was very brittle, almost colourless, and very hard. Water was not required to facilitate the removal of the essential oil as appears necessary in the case of *P. bicolor.*

Of the residue, 33·12 per cent. of resin was dissolved by ether. This is also a bright, clear, hard, brittle resin, and slightly yellowish in colour.

Alcohol dissolves 1·639 per cent. of this residue, removing a resin much resembling that dissolved by ether in colour and general appearance, although quite insoluble in that solvent. Total resins dissolved, 77·719 per cent.

After treatment with the above solvents, the residue was treated with water for 24 hours, when 4·05 per cent. was dissolved out. This proved to be arabin.

When treated with soda solution (·1 per cent.), this residue was dissolved to the extent of 2·38 per cent., of which 1·19 was precipitated by alcohol. On acidifying with acetic acid metarabin was shown to be present. The remainder was principally colouring matter (?).

Hydrochloric acid solution appears to have little action upon this residue, only ·57 per cent. being extracted.

The remainder (15·281 per cent.) was insoluble gum and a trace of impurities.

Summary.

Resin soluble in light petroleum	35·361
Essential oil	7·599
Resin soluble in ether	33·120
„ „ alcohol	1·639
Arabin	4·050
Soda in soda solution; 1·19 per cent. is metarabin...	2·380
Soluble in hydrochloric acid solution	·570
Insoluble gum and impurities (by difference)	15·281
	100·000
Or by actual determination—insoluble gum and impurities =	14·290
Or a total of	98·999

Examination of the Substances removed from the Gum-Resin by Ether direct.

·749 gram of the purest gum-resin obtainable was treated directly with ether, when 75·167 per cent. of resin + essential oil were dissolved out; after heating at 110° C. until a constant weight was obtained, the resin was found to be 66·620 per cent., showing a percentage of 8·547 per cent. of volatile oil driven off. On adding water and again heating no difference was discernible.

From the residue, alcohol dissolved out 1·462 per cent. of a hard resin.

Total dissolved by ether and alcohol = 76·629 per cent. The remainder, 23·371, was a clean white gum, which is but slightly soluble in water, but which swells in that liquid.

The quantity of ash is ·71 per cent.

Comparing the gum-resins of *P. bicolor* and *P. undulatum* the following points are noticed:—

1. The odours are distinct, and apparently characteristic.

2. The melting point of *P. undulatum* gum-resin is lower than that of *P. bicolor*, doubtless because of the higher percentage of resin it contains.
3. The gum-resin of *P. bicolor* has the greater tendency to indurate, doubtless owing to the higher percentage of gum it contains. In *P. bicolor* the outer portion of the lumps consists of the dried gum-resin minus the volatile oil with which it was associated, and the intractability of this indurated substance with solvents appears to arise partly from the intimate association of the gum and resin, and partly because of weathering.
4. The resin of *P. bicolor* is of an orange-yellow colour, differing from that of *P. undulatum*, which is almost colourless in samples I have examined.

Pittosporum rhombifolium. "White Holly" of the Richmond River.

A small quantity of gum-resin has been collected from this species; it does not appear to be sensibly different to that of *P. undulatum.*

I desire to express my obligations to my Laboratory Assistant, Mr. Henry G. Smith, for much valuable help in the preparation of this paper.

14.—ON THE PRESENCE OF MAGNETITE IN CERTAIN MINERALS AND ROCKS.

By A. LIVERSIDGE, M.A., F.R.S., *Professor of Chemistry in the University of Sydney.*

The following experiments to determine the amount of magnetite or of magnetic particles in minerals and certain rocks were made in consequence of the following statement in Bauerman's Systematic Mineralogy, p. 298, 1881; viz.—"Chrome iron and Franklinite are magnetic, but it is not certainly known whether this is a special property or caused by finely interspersed magnetite." Other writers, like Dana, simply state that the above minerals are magnetic, but do not make any comment as to whether the magnetic properties are inherent in the minerals named or due to enclosed magnetite;

hence I thought it would not be altogether a waste of time to put the matter to the test of experiment. Accordingly I had some of the more common ferruginous and magnetic minerals crushed to a fine powder, sifted through a No. 60 sieve, and then acted upon by an electro-magnet under water. An electro-magnet was used because it is very difficult to brush off all the magnetic particles from an ordinary permanent bar or horse-shoe magnet, even when the armature is on. The magnet used lifted a weight of 18 ounces. A comparatively feeble one was purposely used, so as to attract and remove only those particles which would be attracted by a good ordinary permanent magnet; a powerful electro-magnet would not have been so suitable for the object in view.

The crushing was effected in a porcelain mortar, and finished in an agate one, to prevent access of particles of iron, which of course are always abraded from iron pestles and mortars. The non-magnetic matter can only be separated from the magnetic portions by repeated applications of the magnet and regrinding, because a certain amount of the non-magnetic powder is apt to be entangled with the magnetic.

Inasmuch as Hæmatite, Fe_2O_3, is often somewhat magnetic, this was chosen as one of the first minerals to be tested for magnetite.

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1. *Hæmatite.*—A dark compact red Hæmatite; locality unknown, but probably from Elba. Acted on magnetic needle. The powder yielded—

	Grammes.
Magnetic particles	10·15
Non-magnetic	56·80
	66·95

Or 15 per cent. of Magnetite.

2. *Hæmatite.*—Dark red botryoidal massive Hæmatite, mixed with a little quartz. Frizenton, Cumberland, England. Yielded no magnetic particles.
3. *Hæmatite.*—The same as the last, but a softer variety. This also did not yield any magnetic particles.
4. *Micaceous Hæmatite.*—From the Island of Tanna, where it is used by the natives for dusting over the body, for ornamental purposes, on account of its

being in the form of bright glistening scales. This specimen is evidently of recent volcanic origin, and resembles the micaceous iron from Vesuvius and other volcanoes. It did not yield any magnetic particles.

5. *Micaceous Hæmatite.*—Locality unknown. Yielded traces of magnetic particles.

	Grammes.
Weight of powder	18·7
Weight of magnetic particles	·122
Percentage of magnetic particles	·06

6. *Brown Hæmatite.*—Hydrated sesquioxide of iron. A hollow concretion; locality unknown, but probably from the Waianamatta shale; of a dark reddish brown colour. 51 grammes were crushed, but no magnetic particles obtained.

6A. *Stalactite* of hydrated sesquioxide of iron from Berrima, N.S.W. 26·62 grammes yielded only a trace of magnetic oxide.

7. *Dark Brown Hæmatite.*—Locality unknown. 22·5 grammes were treated, but no magnetic particles obtained.

8. *Brown Hæmatite.*—Compact, and of a dark yellowish brown colour, from Kandern, Baden. 44 grammes were treated, but no magnetic particles were obtained.

9. *Goethite.*—Yellow fibrous structure from Kleinschmalkalden, Hessen. No magnetic particles were obtained from 43 grammes.

10. *Goethite.*—Crystallised, from Lostwithiel, Cornwall, England. No magnetic particles.

11. *Goethite*, from Wallerawang, like the preceding, also from irregular deposits in the sandstone. Yielded an almost black powder. No magnetic particles.

12. *Brown Hæmatite* from the quarry above the House of Correction, Hobart, Tasmania, where it occurs in thin crystalline plates, filling joints in the rock, which are about quarter across. Free from magnetic particles.

13. *Brown Iron Ore* from Hungary. Compact, dark yellow-coloured. No magnetic particles from 58 grammes of the powder.

14. *Stalactitic Brown Hæmatite.*—Wallerawang, N.S.W., with bright black psilomelane-like coating. No magnetic particles.

Analysis.

Moisture	1·28
Combined water	12·04
Iron sesquioxide	73·60
Phosphoric oxide	·12
Sulphur trioxide	·06
Insoluble in acid	12·19
Loss	·71
	100·00

See "Minerals of New South Wales," p. 96.

15. *Brown Hæmatite.*—Dark brown in colour. No magnetic particles from 33 grammes of the powder.
16. *Brown Hæmatite*, Wallerawang. Massive. Gave dark red brown powder. May have been "roasted" in a bush fire. No magnetic particles.
17. *Brown Hæmatite*, Wallerawang. Loose structure. Gave yellow brown powder. No magnetic particles.
18. *Loose Brown Hæmatite.*—Wallerawang. No magnetic particles.
19. *Brown Hæmatite.*—Near Hobart, Tasmania. Dark brown colour; massive. Yielded light brown powder. No magnetic particles.
20. *Pea Iron Ore.*—Brown Hæmatite. Locality unknown. No magnetic particles.
21. *Brown Hæmatite.*—New Guinea. Yielded a trace of magnetic particles.
22. "*Ironstone.*"—Brown Hæmatite. Reigate, Surrey, England. No magnetic particles.
23. *Limonite.*—Clay Band, Wallerawang, N.S.W.; of a dark red brown colour, looks as if it had been calcined; powder also red. A trace only of magnetic particles.
24. *Limonite.*—Clay Band, Wallerawang, N.S.W. No magnetic particles.
25. *Brown Hæmatite.*—Brazil. Pseudomorphous after iron pyrites, auriferous. No magnetic particles.
26. *Ferrous Carbonate.*—Jamberoo, N.S.W. See "Minerals of New South Wales," p. 99. 35·1 grammes of powder yielded no magnetic particles. In another case 64 grammes of powder were also found to be free from magnetic particles.
27. *Iron Carbonate.*—A nodule from the coal measures. England. No magnetic particles.
28. *Iron Carbonate.*—A septarian nodule. No magnetic particles.

29. *Kraurite or Dufrenite.*—Green iron ore, hydrated iron phosphate. Ullersreuth near Hof. No magnetic particles.
30. *Hornblende Schist.*—New Caledonia. Contained a little magnetite.
31. *Spinel.*—Magnesium aluminate.—Ceylon. Red, transparent. No magnetic particles.
32. *Spinel.*—Elba. No magnetic particles.
33. *Spinel.*—Warwick, New York, U.S.A.; in large black octohedra. 32·102 grammes yielded ·094 grammes of magnetite. Spinel crystallises in the same form as magnetite, and has the same general formula; hence the presence of magnetite, even in quantity, would not be surprising.
34. *Garnet.*—Franklin, New Jersey, U.S.A. Common iron alumina garnet of a brown red colour. Did not yield any magnetic particles.
35. *Franklinite.*—Sussex Co., New Jersey, U.S.A. Strongly magnetic; 28·292 grammes yielded 9·131 grammes of magnetic particles, or 32·23 per cent.
36. *Chrome Iron.*—New Caledonia. Massive, black, with granular structure, but mixed with some steatite. When crushed the powder was of a grey tint, and did not yield any magnetic particles.
37. *Chrome Iron.*—New Caledonia. Massive, black. 95·7 grammes yielded ·663 grammes, or ·14 per cent. of magnetic particles.
38. *Chrome Iron.*—Wollomi, N.S.W. Black, massive; no visible foreign matter except a few particles of steatite. 100 grammes of powder only yielded a trace of magnetite.
39. *Pyrrhotine*, or Magnetic Pyrites, was found to be wholly attracted by the magnet, *i.e.*, its magnetic properties are apparently not due to the diffusion of particles of magnetite throughout its substance.

39A. *Pyrrhotine*, from Sala, Sweden, was also found to be wholly magnetic, except a small quantity of associated earthy gangue.

40. *Auriferous Hæmatite.*—Mount Morgan. 11·53 grammes were crushed and passed through a 60-sieve. No magnetite found.
41. *Jeweller's Rouge.*—Found to be free from magnetic particles.

42. *Artificially* prepared dry ferric hydrate was also found to be free from magnetic particles.
43. *Bornite*, or Purple Copper Ore.—Carn Brae Mine, Cornwall, England. Did not yield any magnetic particles.
44. *Iron Pyrites.*—Joshua's Creek, Taupo, New Zealand. The specimen is of recent origin, and in process of deposition round decaying wood and twigs in the stream of hot water supplying the baths. In parts it is black and powdery, but was found to be free from magnetic particles.
45. *Tinstone Conglomerate.*—Vegetable Creek, New England, N.S.W. This consists of rolled tinstone, quartz, &c. cemented together by iron oxide. 62·4 grammes of the powder was sent through a 60-sieve, but no magnetic particles were detected.
46. *Serpentine.*—Dark oily green colour, from Tasmania. 234 grammes yielded 8·4 grammes magnetic particles. Magnetic portion = 3·589 per cent. Another specimen of 50 grammes yielded 2·389 grammes of magnetite.
47. *Serpentine.*—Tasmania. Green, with visible specks of magnetite. 356·5 grammes gave 28·501 grammes of magnetic particles, or 7·99 per cent.
48. *Serpentine.*—New Caledonia. Dark brown, with veins of steatite and of magnetite. 212 grammes gave 5·92 grammes of magnetic particles, or 2·79 per cent.
49. *Serpentine.*—New Caledonia. Similar to last. 173·5 grammes gave 8·86 grammes magnetic particles, or 5·10 per cent.
50. *Serpentine.*—New Caledonia. 26·2 grammes gave a trace only of magnetic particles.
51. *Serpentine.*—New Caledonia. 62·20 grammes gave 1·990 grammes of magnetic particles, or 3·19 per cent.
52. *Serpentine.*—New Caledonia. 25·7 grammes gave 3·67 grammes of magnetic particles, or 14·28 per cent.
53. *Serpentine and Asbestos.*—Tasmania. 24·0 grammes gave only a trace of magnetite. All the asbestos was separated before crushing.
54. *Serpentine.*—Lucknow, N.S.W. Very dark, almost black, with thin films of steatite. 33·80 grammes gave 7·773 grammes magnetic particles, or 22·99 per cent. A second specimen of the same, weighing

24·149 grammes, yielded 6·08 grammes magnetite, or 25·13 per cent.

55. *Serpentine.*—Scotland. 28 grammes gave no magnetic particles.

All the serpentines examined acted upon a common five-inch magnetic needle, except Nos. 50, 53, and 55; No. 47 from Tasmania, and 49 from New Caledonia, were also distinctly polar. No nickel iron or awaruite was found in any of the serpentines.

Conclusion.

As far as the foregoing experiments are concerned, they show that in the specimens examined the magnetic properties of Chrome Iron, Franklinite, Spinel, Garnet, some Hæmatites, and other minerals and rocks are due to the presence of scattered particles of magnetite. In most cases the magnetic separated portion was further tested chemically, and proved to be magnetite, but it was not thought necessary to do this in every case. The Pyrrhotine, however, appears to possess inherent magnetic properties.

15.—ON IRON RUST POSSESSING MAGNETIC PROPERTIES.

By A. LIVERSIDGE, M.A., F.R.S., *Professor of Chemistry in the University of Sydney.*

My attention was first drawn to this matter in January, 1889, when walking along the pier at Clifton Springs, Port Arlington, Victoria, by noticing the large scales of rust attached to the old tram rails, which had not been in use for some years. On breaking off fragments I was much struck by their resemblance to the crust seen on many metallic meteorites. Some of the pieces were from a quarter to one-third of an inch through, one to two inches wide, and three to four inches long. Although retaining somewhat the form of the original iron they were very brittle, and, on breaking them across, the fracture had a slight resemblance to that seen in some non-crystalline magnetites. Further, on scraping the rust and breaking pieces off with a pocket-knife, the dust and fragments were strongly attracted to the blade which had been magnetised. I could see no traces of metallic iron, and felt sure that practically there were no

particles of the metal in the rust. I could not, of course, make quite certain without other appliances, so on my return to Sydney I examined the rust carefully for metallic iron by grinding it in an agate mortar, but could not find the smallest speck of metal; the material ground readily to the last portion and yielded a dark brown coloured powder, and, to my surprise, I found the powder to be *wholly* attracted by the magnet, and not merely in part as I expected. I did not care to publish the above as it rested upon observations made upon a single specimen, and was directly opposed to the usual statements in text-books and works of reference on chemistry, that rust is a non-magnetic hydrated sesquioxide of iron, and an opportunity to proceed with the matter did not occur until September last.

It may be thought that more has been made of the matter than its comparative unimportance warrants, but as my results are at variance with the general statements placed before students and others, statements which are of so many years standing, it is perhaps not unjustifiable to place sufficient evidence on record to establish the facts and place them on a firm footing. Fortunately the statements can be verified by anyone possessing a magnet, no matter how poor a one it may be, inasmuch as material can be obtained from any old piece of rusty iron.

Since then I have been able to examine other specimens of rust and to make a few experiments upon the matter, all of which bear out the original observation, and show that ordinary iron rust is usually attracted by the magnet.

By magnetic rust or oxide in this paper is meant iron oxides which are attracted and lifted by a small bar magnet of one-eighth inch in diameter, or by an ordinary penknife blade which had been magnetised; but when seeking to separate large quantities a bar magnet which would lift 4 ozs. of iron or an electro-magnet lifting 18 ozs. was employed. As mentioned in the preceding paper, a powerful electro-magnet was considered inadmissible.

In spite of all the care exercised in grinding and using the magnet under water, there may still be some non-magnetic oxide mechanically enclosed and carried over by the magnetic particles, as is seen when it is attempted to separate sulphur and iron filings by a magnet; but from the number of times that the same powder can be lifted without leaving anything behind I think it cannot amount to much, and may be neglected as unimportant.

The source of the iron rust and the conditions under which it had been found are given in what might appear as unnecessary detail, but full particulars are furnished so that it may be seen that iron of various qualities, *e.g.*, common cast, inferior, and the best malleable iron and steel all furnish rust containing magnetic oxide in the early stages of the rusting, and that under certain circumstances the final products—the sesquioxide and hydrated sesquioxide of iron—may also be magnetic.

Metallic iron was tested for in every case by careful examination for specks of metal when grinding in the agate mortar, and also by digesting the powder in a solution of iodine in potassium iodide for some hours, but proved to be absent, except in one or two cases, which are mentioned further on.

No. 1.—*Rust from Iron Rails*: Clifton Springs, Port Arlington, Victoria.

This specimen was collected, as stated above, in January, 1889, from the old tramway on the pier at Clifton Springs, Port Arlington, Victoria.

9·1 grammes were crushed and sent through a No. 60 sieve. The dark brown powder was wholly attracted by the magnet, the amount of non-magnetic powder left after repeated applications of the magnet being almost invisible. The attempted separation of any non-magnetic matter was repeated time after time, so as to get rid of any entangled non-magnetic dust, but always with the same result.

The rust was also acted upon by the magnet under water, after re-crushing to an impalpable powder in an agate mortar. This was done to avoid, as far as possible, non-magnetic oxide being lifted mechanically between or by attached particles of magnetic oxide; but, after many repeated attempts to obtain non-magnetic rust from it, I had to come to the conclusion that it was all attracted by the magnet.

Another attempted separation was made on 5·640 grammes powdered in an agate mortar, but with a like result, *i.e.*, the whole was attracted.

These scales of rust were found to be not only magnetic but some were also polar, *i.e.*, they not only attracted one end of the magnetic needle but also repelled the other, and the opposite edges of the fragments possessed opposite polarities; moreover, when suspended in a stirrup by unspun

silk some specimens set themselves in the magnetic meridian, a further proof of their being magnetic and not merely lumps of ordinary rust containing particles of metallic iron.

The specific gravity was found, by Joly's apparatus, to be 4·07 at 18°, native magnetite being 4·9 to 5·2.

A portion of this rust yielded 70·11 per cent. metallic iron (by the bichromate volumetive process), the theoretical amount in magnetic oxide, Fe_3O_4, being 72·41 per cent.

To confirm or otherwise the results obtained from the old rail, rust specimens were collected from various sources, and these on examination verified the previous observations in almost every particular.

The rust in each case was scraped off with a horn spatula and crushed in a porcelain mortar, and the precautions taken were such as to prevent any metallic iron finding its way in; further, the magnetic powder was in every instance proved to be free from any particles of iron.

No. 2.—*Rust from an old iron waggon* lying on Lady Robinson's Beach, near Sydney.

The scales are about $\frac{1}{8}$-inch thick, and come off in large flakes five or six inches across. On the outside, as well as the inside (*i.e.*, next to the still unoxidised iron of the waggon), they present the usual appearance of rust, being scaly and of a dark-brown colour with light ochrey patches, with here and there a small cone-like excrescence. Specific gravity at 16° C. = 3·76.

On breaking the scales across they present a dark—almost black—coloured interior with a well marked fibrous crystalline structure, such as is seen in many Goethites. This internal part gives a dark-brown streak or powder, the outer film gives a pale ochre-coloured powder. The rust is picked up bodily by a magnet—whether a magnetised knife-blade, a horse-shoe, or electro-magnet is used—and some of the scales show well marked north and south poles. On being crushed it yielded a dark-brown powder, which was found to be wholly lifted or attracted by a magnet, *i.e.*, no non-magnetic portion could be obtained from it.

In one case 409 grammes were crushed and sent through a No. 30 sieve; only one gramme was left by the magnet, and this was seen to consist of rounded grains of sand from the beach.

Another portion was crushed and sent through a No. 60 sieve; this likewise was wholly attracted by the magnet.

A third portion was scraped on both surfaces before crushing. The outer crust or scrapings—5·25 grammes—gave a yellowish brown-coloured powder, which was wholly lifted by the magnet; the inner dark and crystalline part, weighing 432 grammes, gave a brown powder and was also entirely magnetic.

Cakes of this and other rusts, $\frac{1}{8}$ to $\frac{3}{16}$ inch, and of 3 or 4 inches superficial area, are drawn to a horse-shoe magnet capable of sustaining a pound weight of iron, with a slight jump like pieces of thin sheet-iron, but with, as might be expected, very much less readiness.

No. 3.—*Rust from an old wrought-iron 400-gallon water-tank*, made of thin "boiler" plate, and used for shipping malt to Sydney.

Specific gravity = 3·90 at 18° C. This had the usual appearance of rust scales, but was strongly magnetic. Distinct north and south poles were shown by some of the large pieces; 13·3 grammes were crushed and sent through a No. 60 sieve; the brown powder was wholly lifted by the magnet. A second sample, weighing 10·545 grammes, was also found to be wholly magnetic.

Another fragment or scale was crushed in an agate mortar, and 10·205 grammes of an impalpable brown powder obtained. This was placed in a glass spitz-kasten (or Knop's soil-washing apparatus), and separated into three portions of different specific gravities, but all were found to be attracted by the magnet.

The yellow ochre-like superficial rust from some of these scales, 8·096 grammes in weight, was ground to an impalpable powder and dried in a water-oven; and even this was wholly attracted by the magnet, although feebly.

No. 4.—*Rust from an old flue pipe*, but which had never been used.

Some of this was powdered and sent through a No. 60 sieve; the light brown coloured powder yielded 2·25 of strongly magnetic and 2·3 grammes of feebly magnetic powder.

No. 5.—*Rusts from old bolts, bars, &c.*, which had been lying exposed to the weather in a wooden box.

Of the usual "rust colour" and appearance. The powder yielded—Magnetic particles, 7·71 grammes; non-magnetic particles, ·205 grammes.

No. 6.—*Rust from old wrought-iron tyre.*

Weight of powder = 4·691 grammes. In separating this under water a certain amount of fine powder was obtained in suspension, and this apparently was not attracted; at any rate it could not readily be removed from the water by the magnet, but on evaporating it down on a sand bath it was found to be wholly lifted by the magnet.

Another specimen of the same, weighing 9·856 grammes, was crushed in an agate mortar, dried in water oven, and also found to be wholly lifted by the magnet.

No. 7.—*Rust from old sheet iron barrow*, probably formerly galvanised.

The scales showed well defined north and south poles.

146 grammes were crushed and passed through a No. 30 sieve. The whole of the dark brown powder was found to be attracted by the magnet.

No. 8.—*Rust from old disused boiler-plate chimney.*

60 grammes were crushed and passed through a No. 30 sieve, and yielded a dark brown powder, the whole of which was magnetic. The scales were also polar.

This example is not of so much value as the others, because it might be thought that the scale consisted of or contained magnetic oxide (Fe_3O_4) which had been formed at a high temperature, although personally I am satisfied that it was formed by the ordinary process of atmospheric rusting.

No. 9.—*Rust from old tinned-iron can.*

All traces of metallic tin had disappeared. 1·6 grammes were crushed and passed through a No. 60 sieve; the light brown powder was wholly lifted by the magnet.

No. 10.—*Rust from scrap heap.*

In the form of cakes, from $\frac{1}{16}$ to $\frac{1}{8}$ inch in thickness, and of several inches superficial area. The cakes were of the usual dark brown colour, but with soft powdery yellow-ochrey patches and cones or excrescences. These were detached and ground separately in an agate mortar, and found to be nearly free from magnetic particles, but the soft black powder found under the excrescences or pimples was highly magnetic.

No. 11.—*Rust from flat iron bars.*

These had been left lying on the ground exposed to the weather; the whole of the rust was highly magnetic.

No. 12.—*Rust from cast iron gas plug box.*

14·26 grammes were passed through a No. 60 sieve, and found to be wholly magnetic.

This rust was in the form of thick scales, strongly magnetic, and when broken open presented in places a crystalline structure. Under the microscope some of the crystals could be recognised as more or less well-formed octohedrons of a bluish-black metallic colour and lustre, and they doubtless were crystals of magnetite. The scales of rust were found to have in one case a sp. gr. of 4·23 at 15° C.

No. 13.—*Rust from old gate hinges.*

These had been left lying in an open barrel; the powdered rust was wholly magnetic.

No. 14.—*Rust from Sydney water mains.*

The Sydney water mains choke up very rapidly with "rust," and have in consequence to be replaced from time to time. The deposit consists of hydrated sesquioxide of iron, iron monoxide, silica, alumina, lime, sodium chloride, &c., organic matter, and some free sulphur; the last is derived from the reduction of sulphates by the organic matter.

50 grammes of the rust from the interior of some 6-inch mains, kindly supplied to me by Mr. Houghton, gave, when crushed in a porcelain mortar and passed through a No. 60 sieve, 9·33 grammes of magnetic particles.

50 grammes from another specimen less finely ground gave 6·79 grammes of magnetic oxide.

A third sample was passed through a No. 90 sieve, and then ground in an agate mortar, but it gave much trouble from clogging together into cakes. 22·719 grammes of this were washed in a Knop's soil-washing apparatus. Some of this was washed away and lost from its extreme lightness, but the 4·02 grammes of black powder left were entirely magnetic.

No. 15.—*Rust from decayed gas pipes*, Melbourne.

Mr. G. Foord, F.C.S., of the Melbourne Mint, examined in 1867 certain gas pipes which had been almost wholly

converted into ferric hydrate. (See Decay of Gas Pipes in certain Soils. G. Foord. Transactions Royal Society of Victoria, 1874).

It was found that the gas pipes near the site of the Melbourne Old Exhibition were subject to very rapid decay. The site is one hundred feet above high water-mark of Hobson's Bay. The porous soil of harsh nearly white mottled permeable clay is also favourable to drainage by percolation, and described as free from any constituent likely to corrode the pipes unduly.

He found the specific gravity to be—

A.—Undecayed portions	5·99
B.—Decayed portions	2·57
C.—Portion with thin inner shell of metallic iron...	2·88
D.—Grey cast iron, for comparison	7·10

"The decayed portion had lost to some extent, but not altogether, its magnetic properties. It is easily reduced to a greenish brown powder, approaching the tint of raw umber. On solution in hydrochloric acid it evolves no hydrogen, a fact which shows that it contains no residue of iron in the metallic state; when thus dissolved it leaves a bulky residue of graphite, with silicon, carbon, and sulphur compounds of iron and manganese."

"The converted portion when newly taken from the ground is soft, but hardens on exposure."

Further details are given, but the above are sufficient for my present purpose, except that it may be stated that Mr. Foord attributes the rapid oxidation and decay to the action of soluble chlorides in the soil, as has been stated to be the cause in other places.

A piece of the decayed pipe was forwarded by Mr. Foord in 1869 to the late Dr. Smith, Professor of Physics in the Sydney University, who gave it to me some years ago when I was examining some cast iron which had been acted upon by sea water. (Journal Royal Society of New South Wales. Vol. 14. 1880.)

The fragment resembles a curved shell-like piece of limonite. On crushing it yields an ochre-coloured powder, which is in part attracted by the magnet, but free from particles of metallic iron. Another piece weighing 7·397 grammes yielded a little iron to iodine in potassium iodide, but was still wholly magnetic after the removal of the metallic iron. Other portions did not yield any iron to iodine in potassium iodide.

No. 16.—*Rust from hot-water pipe*, Prince Alfred Hospital, Sydney. An ordinary $1\frac{1}{2}$-inch pipe.

Of a red brown colour, and feebly magnetic.

No. 17.—*Rust from cold-water $1\frac{1}{2}$-inch pipe*, Prince Alfred Hospital, Sydney.

Partly magnetic. The non-magnetic portion contains much organic matter.

No. 18.—*Rust from screw and nail*, which had been exposed for a few months on a window sill.

They were both covered with a thin coat of dark brown oxide. The rust from both was attracted by the magnet, but not wholly; the quantity was small, and no attempt was made to weigh or estimate the amount.

19.—*Rust from old bolt.*

A small part of this was non-magnetic, but became feebly attracted after boiling in water.

The writer has on various occasions cited the skin of magnetic oxide on meteorites as a proof of the high temperature to which they have been subjected in their passage through the atmosphere; but in some cases this may perhaps have been found in the ordinary way, inasmuch as the foregoing experiments seem to show very clearly that the oxides yielded by the atmospheric rusting of iron may also be magnetic.

Experiments on the Rusting of Iron.

While the volume has been going through the press I have been able to obtain additional results from certain experiments which were going on when the paper was read, especially those upon sheet iron, nails, &c. which had been placed out to rust or immersed in cylinders of distilled water, &c.

The results do not differ from those already obtained and stated when the paper was read, but the extra time has enabled me to get thicker and heavier deposits of oxide, which are more satisfactory than thin films.

Black sheet iron was scoured with pumice-stone until perfectly bright, clean, and free from scale, and cut into strips 7×2 inches. The strips were then put up into lots of about 1 lb. each.

Experiment No. 1.—A hole was punched in each strip and a bundle of them suspended by a bright iron wire outside a window, on September 11, 1891, when they weighed 456 grammes. On February 16, 1892, *i.e.* after 19 weeks' exposure, these were scraped with a horn spatula and 2·14 grammes of rust obtained, of which only ·184 grammes, or 8·6 per cent., was non-magnetic. The colour of rust was ochrey outside and black inside.

Experiment No. 2.—A second lot of 457 grammes was suspended in the same way on the roof of the Chemical Laboratory. On February 16, 1892, *i.e.* after 19 weeks' exposure, these also were scraped with a horn spatula and yielded 6·6 grammes of rust, of which only ·775 was non-magnetic, or 11·7 per cent. The rust was of the usual colour outside, but nearly black underneath.

Experiment No. 3.—A third bundle of sheets, weighing 453 grammes, was placed in a 24-oz. stoppered cylinder of boiled distilled water on September 11, 1891. This iron was scraped on May 27, 1892, after 36 weeks' action, with a horn spatula, and brushed with a new nail-brush, and yielded 2·604 grammes of blackish oxide, of which the whole was attracted by the magnet.

Experiment No. 4.—A further bundle of 453 grammes was placed in a similar stoppered cylinder of unboiled distilled water, treated in the same way as Nos. 2 and 3, and on the same dates. Yielded ·694 grammes of dark brown oxide, wholly lifted by the magnet.

Experiment No. 5.—453 grammes of strips were similarly placed in a cylinder of tap water on May 27. They were taken out, dried on a water bath, scraped with a horn spatula, and carefully brushed; the rust weighed ·538 grammes; it was of a dark brown colour, and wholly attracted.

Experiment No. 6.—A bundle of strips, weighing 449 grammes, was placed in cylinder of distilled water charged with carbon dioxide. Treated in the same way as the others and on the same dates. This yielded ·545 grammes of a dark yellowish brown colour. Some of the oxide in this case was in the form of brown iridescent films floating in the water. These brown films were also found to be magnetic after boiling; they were also found to yield no blue colouration with potassium ferricyanide added to thin solution in hydrochloric acid. In all the other cases (1 to 5) the loose oxide floating in the water and attached to the iron was black.

Experiment No. 8.—453 grammes of bright 2-inch wire nails were exposed in a photographic dish on a window sill from September 11, 1891, to February 16, 1892. These nails were moistened from time to time, but not kept constantly wet. On scraping off the rust with a horn spatula, 7·79 grammes of rust were obtained, the whole of which was magnetic.

Experiment No. 9.—453 grammes of 6-inch bright wire nails were similarly exposed and treated at the same time. These nails only yielded 4·03 grammes of rust, which was also wholly magnetic. The smaller surface exposed by the larger nails accounts for the smaller weight of rust produced.

Experiment No. 10.—On September 21, 1891, 906 grammes of bright 6-inch wire nails were put out on a window sill (facing W.) in a new photographic dish, and covered with distilled water. After three days, *i.e.* on the 24th, they were covered with loose ochrey rust which washed off readily, but under this and filling the striæ of the nails was a film of black oxide. When scraped on February 16, 1892, with a horn spatula, they yielded 4·03 grammes of rust of a dark brown colour, and entirely attracted by the magnet.

Experiment No. 11.—At the same time and place $1\frac{1}{2}$ lbs. of bright $2\frac{1}{2}$-inch wire nails were also put out in a photographic dish with the same result, except that there was very much more of the black oxide present.

On turning over the nails Nos. 10 and 11 on the 26th, *i.e.* after five days' exposure, it was found that, while covered more or less completely with ochrey rust on the upper surface, the lower surfaces of the nails (which were completely immersed in the water) were free from it, but coated instead with a closely adherent film of black oxide, due apparently to the fact that, while there was sufficient oxygen on the exposed side of the nails to form both the red or ochrey and black oxide on the lower side (completely immersed in water) the oxidation did not go beyond the first stage. On February 16, 7·79 grammes of entirely magnetic rust were obtained.

The total amount of rust furnished by this experiment and No. 10 was much more than the weights given. The loose rust in the dishes was not weighed, because it was mixed with grit and dust which had fallen into the dishes during their exposure.

Experiment No. 12.—Some sheets of clean iron were also placed out but not moistened. The rust was much darker

in colour than that from experiments 10 and 11, being of a dark reddish brown when scraped off with a horn spatula, and powdered. The oxide weighed 2·14 grammes, of which ·184 was non-magnetic.

Experiment No. 13.—On September 21, 1891, 736 grammes of bright 6-inch wire nails were placed in a stoppered cylinder of hot and freshly boiled distilled water. In the course of a day or two they were coated with black oxide. On May 31 the oxide was collected, but only amounted to ·131 grammes, which was feebly magnetic.

Experiment No. 14.—702 grammes of bright 6-inch wire nails were put up with distilled water charged with carbon dioxide. Gave only ·211 of rust, of which but a small part was magnetic.

Experiment No. 15.—On September 22, 1891, 433·5 grammes of bright wire nails were placed in a stoppered cylinder, and dry ozonised oxygen from a Siemen's tube passed in for 20 minutes. These nails were hardly rusted, and there was insufficient rust to remove.

Experiment No. 16.—415·3 grammes were also put up in the same way, and moist ozone passed in for about 20 minutes. Yielded on May 31, 1892, 1·437 grammes of highly magnetic oxide.

The absence of metallic iron was in these cases proved by grinding it in an agate mortar, and in certain cases also by means of iodine.

Literature.

Although the results of previous investigators should usually have precedence, they are given at a later stage of this paper mainly because most of my experiments were carried out before I had time to fully look up the literature of the subject. The immense number of publications and amount of matter to be gone through nowadays is so overwhelming that if, in all cases, the necessary searches were to be made before experimenting, many questions which crop up would never reach the experimental stage at all.

In the first instance I had, from want of time, to be content with reference to the chemical dictionaries and other standard works on Chemistry, and as they were silent upon this subject, or stated that there was only one oxide of iron possessing magnetic properties, I went on with the experiments, and they were practically finished before I was able to go through the journals devoted to Chemistry and allied subjects.

From the quotations which follow, it will be seen that the views of the older chemists more closely correspond with my results than those of some of the more recent writers.

Most modern writers state that rust is non-magnetic, and is formed only in the presence of air, moisture, and carbon dioxide, as follows :—

$$(a)\ Fe + CO_2 + O = Fe\,CO_3$$
$$(b)\ 2FeCO_3 + O = Fe_2O_3 + 2CO_2$$
$$(c)\ Fe_2O_3 + 3H_2O = Fe_2O_3\,3H_2O = \text{rust.}$$

This of course may more or less explain the reactions, but it evidently is too neat and complete, inasmuch as it does not account for the large proportion of magnetic oxide which always appears to be present in ordinary rust.

Another reaction commonly given is $Fe + H_2O + CO_2 = FeCO_3 + H_2$, and that the $FeCO_3$ formed takes up more CO_2 and is converted into the soluble acid carbonate, which in turn is converted into the insoluble ferric hydrate (Fe_2O_3, $3H_2O$) or rust, and that the CO_2 is free to act again, but this is equally imperfect. Mendeleef ("Principles of Chemistry," London, 1891, p. 321), amongst modern writers, recognises the fact that rust contains both ferrous and ferric oxides, but makes no mention of its magnetic properties.

In looking up the matter reference was first made to the later publications, but it was only in those published over 30 years ago that anything was met with really bearing upon the subject, the most interesting and valuable being the Note by Mr. Robbins in the *Chemical News* for 1859, and the paper by M. Sarzeau in 1860, also in the *Chemical News*; both of these, however, seemed to have been ignored or overlooked by late writers.

The following quotations are arranged according to their dates of publication :—

It is stated in the "Dictionary of Chemistry and Mineralogy," by A. & C. R. Aiken, 1807, on p. 612, that "The common rust which collects upon hammered iron by exposure to air and moisture, and which in time corrodes the thickest bars, is not the simple oxyd, but a carbonated oxyd, or a compound of iron, oxygen, carbonic acid, and water, and is not of itself magnetic, unless mixed with fragments of iron detached by the rusting."

It is stated, too, that iron will oxidise and hydrogen be given

off "even at the common temperature of the air, but the oxyd will then be in the form of a black powder, and will not exhibit that glossy appearance which it does in the former method," *i.e.*, when steam is passed over red hot iron. "The preparation called Martial Æthiops is iron oxidated by water, and was first made by Lemery the younger," by covering a quantity of clean iron filings with water and stirring from time to time. "After a while bubbles of hydrogen constantly rise from the mass, and the vessel becomes full of a very fine black powder. This black powder is iron in the first or lowest state of oxydation or sub-oxyd; it is strongly magnetic, but has a constant tendency to absorb an additional quantity of oxygen from the air or any other substance by which it loses its magnetic property, changes from black to yellow or red, and acquires very different chemical characters."

Further, "Von Mons, having prepared a quantity of this black sub-oxyd, heated it in a retort to drive off the superfluous moisture, but on taking it out "a spontaneous motion or heaving took place through the mass; it became so hot as to burn a thick double paper in contact with it, and the whole in a few minutes was converted into the red or perfect oxyd or saffron of Mars."

Leopold Gmelin, in his "Handbook of Chemistry," vol. v., p. 185, Cavendish Society, 1851, says:—"Iron covered by a thin layer of water and exposed to the air is converted into the hydrated sesquioxide; ammonia is also formed.

"If the iron be covered by a deeper stratum of water so that the transference of the oxygen of the air through the water to the iron may take place more slowly, a formation of black hydrated ferroso-ferric oxide takes place, because hydrated ferric oxide, as it slowly forms, induces the iron to decompose the water and form ferrous oxide, with which the ferric oxide then unites.—(Wöhler.)

p. 186: "Beneath the flocculent hydrated sesquioxide of iron there is formed a thin black crust (of ferroso-ferric oxide?) which adheres firmly to the iron.

"When cast iron of this description (*i.e.*, mixed grey and white) is exposed to the action of a mixture of 75 measures of aerated water and one measure of a saturated solution of chloride of sodium and carbonate of sodium, oxidation begins in a minute, and thus is formed—first, whitish hydrated ferrous oxide and hydrated ferroso-ferric oxide, which at some

distance from the iron are converted into hydrated ferric oxide, and afterwards carbonate and silicate of ferrous oxide, the latter being produced by the oxidation of silicate of iron.

p. 186 : 6. " At ordinary temperatures, and out of contact of air, iron does not decompose thoroughly boiled water, unless it is in contact with more electro-negative bodies, as with previously formed ferric oxide, mercury, &c. In this case, and likewise when the liquid is heated to 50° or 60°, a feeble evolution of hydrogen takes place, and ferroso-ferric oxide appears to be formed.—(Hall, 2 *J.C.S.*, vol. 7, p. 55. Guibourt, *Ann. Chem. Phys.*, vol. 11, p. 43.)

p. 187 : " Ferrous oxide decomposes water by continued contact, and is converted into ferroso-ferric oxide.

p. 188 : " If a ferrous salt be precipitated by ammonia instead of by potash, the precipitate, after long standing, gives off hydrogen gas, becomes gradually darker in colour, and when dried in the manner above described is converted into black ferroso-ferric oxide containing ammonia.—(G. Schmidt, *Ann. Pharm.*, 36, 101.)

" Dried ferrous hydrate is not magnetic (Liebig and Wöhler), and on exposure to the air it is instantly converted into ferric oxide. The heat often rises to redness.

p. 193 : " Iron black or Æthiops (*Martialis Lemeryi*) is a mixture of ferric and ferrous oxides in different proportions, according to the mode of preparation, and is partly hydrated.

p. 194 : " Hydrated Æthiops.—Iron filings are placed in a wide vessel covered with a deep stratum of water, exposed to the air for a considerable time with frequent stirring, the light black powder is decanted from the still unoxidised iron from time to time, collected on a filter, and rapidly dried. This preparation is doubtless identical with the black hydrate of ferroso-ferric oxide already described."

The above quotations are given because they give a more accurate account of the process of the oxidation of iron than some of the more modern writers.

J. Robbins, in a Note on " Magnetic Peroxide of Iron " *Chemical News*, vol. i., 1859, p. 11, states that he ignited some black magnetic oxide of iron on platinum foil over a spirit lamp. " After ignition the black oxide had apparently become converted into the common red peroxide of iron, but on applying the magnet, to my great astonishment I found

that its magnetic properties remained unimpaired. The next question to determine was whether it was still a combination of the two oxides having undergone some molecular change, or whether the protoxide had not become converted into peroxide by absorption of oxygen from the atmosphere. I therefore dissolved some of the red powder in hydrochloric acid, and to the solution added some ferridcyanide of potassium, but not a trace of the protosalt was indicated by that reagent. The magnetic peroxide may also be conveniently prepared by fusing together for some minutes the common black oxide with three or four times its weight of nitrate of potash. Prepared in this way it is more readily dissolved by hydrochloric acid than that obtained by simple ignition.

"I have searched various chemical works, but can find no mention of a magnetic peroxide of iron. I therefore presume that this peculiar compound has escaped observation."

M. Sarzeau (*Chemical News*, I., 1860, p. 137, and *Jour. de Pharm. et Chemie*, 23 Jan. 1860), in describing a method of preparing aerated water from plates of iron placed in a solution of carbonic acid in water at 50° F., says:—"We obtain a liquid with well marked inky flavour, and which has all the properties of a solution of a protosalt of iron. If the liquid be heated it is at first turbid, and then becomes milky, afterwards ochrey, and at last when it boils it suddenly changes to a deep brown. On cooling it deposits a substance of the same colour, which, separated by filtration, dried in the air, and dissolved in hydrochloric acid, gives a mixture of protochloride and perchloride of iron. If a magnet be brought in contact with the brown matter when dry it is found to adhere, showing that by heating a solution of carbonate of iron magnetic oxide is formed."

I did not come across the accounts of the experiments by Mr. Robbins and M. Sarzeau until my own were practically completed, as they are not quoted in any of the Chemical Dictionaries and works of reference, but I have since repeated them, and can confirm their results.

Robbins' experiment of heating finely-powdered magnetite was repeated on several samples of magnetite, and in each case the resulting sesquioxide of iron was found to be wholly attracted by a magnet, although no trace of ferrous oxide could be detected in the red powder by dissolving in hydrochloric acid and adding potassium ferricyanide.

The powder is still attracted by the magnet when hot, but more strongly on cooling, as in the case of metallic iron.

M. Sarzeau's results were confirmed by converting precipitated ferrous carbonate into the acid soluble carbonate by passing carbon dioxide through water containing ferrous carbonate in suspension. On warming this solution or exposing it to the air the carbon dioxide escaped, and a dark coloured precipitate was thrown down. Usually this was found to be attracted by the magnet, but not always. On further warming and longer exposure it gradually acquires a buff colour and becomes magnetic, although not strongly so, but seen by acting upon it with the magnet under water. A temperature of about 70° C. seemed to be the best. At from 270° to 290° C. the colour became red, the magnetic properties being retained even after ignition; the solution in hydrochloric acid showed no trace of ferrous salt with potassium ferricyanide.

There is sometimes a little difficulty in obtaining the magnetic sesquioxide by this process. The cause is not quite clear, but is probably due to the ferrous carbonate not having in all cases been thoroughly washed free from other salts.

Dr. F. Crace Calvert, in a paper on the "Oxidation of Iron," (*Journal Chemical Society*, 1871, p. 198, and *Chemical News*, 1871, vol. 23, p. 98), gives the following analysis of rust:—

	Conway Bridge.	Llangollen.
"Iron sesquioxide	93·094	92·900
Iron protoxide	5·810	6·177
Iron carbonate	·900	·617
Silica	·196	·121
Ammonia	—	—
Calcium carbonate	—	·295"

No remark is made as to whether the rust was magnetic or not, although it probably was; and the same remark doubtless applies equally to the rust described by Mr. Cowper and Dr. F. Muck, as follows:—

"Oxidised Iron from the condenser of H.M.S. *Spartan*," by Richard Cowper, A.R.S.M. (*Journal Chemical Society*, 1882, vol. li., p. 256.)

The specimen was found in part of the tank of a surface condenser, and which in use had been constantly subjected to the action of sea water at a temperature not exceeding 100° F.

It consisted of a brownish substance, in which were embedded numerous shining black particles, and resembled very much in appearance a piece of rusty grey pig iron. Specific gravity, 2·63 only, and extremely friable. A full analysis is given; there was 42·33 per cent. of ferrous oxide and 2·21 per cent. of ferric oxide present.

He states also that a specimen of ordinary iron rust scraped from some cast iron (which had rusted in moist air) gave 65·42 per cent. ferric and 7·42 per cent. of ferrous oxide.

Dr. F. Muck (*Stahl und Eisen*, viii., p. 837–41, also *Journal Iron and Steel Institute*, 1889, i., p. 385), states that the rust in a boiler formed in pits near the feed pipe had a fungoid form, and dried at 100° C. It had the following composition :—

Fe_2O_3	FeO	CaO	MgO	SiO_2	SO_3	CO_2	C	H_2O	Organic
66·84	23·24	2·60	·39	1·18	·28	2·32	·22	2·75	·18

The organic matter was soluble in ether, and probably derived from the lubricants used. "The rust therefore mainly consists of magnetic oxide."

Professor W. Spring (*Bull. Soc. Chim.*, vol. 50, pp. 215–18, and *Journal Society Chemical Industry*, Nov. 30, 1888), says that the cause of iron rails rusting less rapidly when in use than when not subjected to traffic is not due to the vibration of passing trains nor to currents of electricity, nor to a film of grease derived from the engine and carriages, but rather to the formation of a layer of magnetic oxide on their upper surface formed by the pressure of the wheels on the moist ferric oxide with which they naturally become coated. He mixed damp ferric hydrate with minute particles of metallic iron, and subjected the mixture to a pressure of 1000 to 1200 atmospheres, and found that the two adhered, and that the hydrate became black to the depth of ·5 mm. Analysis showed that magnetic oxide had been formed. He also found that the rust taken from a rail contained some magnetic oxide and a little free iron mixed with the ferric oxide, and came to the conclusion that rails in use are protected by the magnetic oxide thus formed by the pressure, just as in the case of iron artificially coated with magnetic oxide.

From the foregoing experiments, and those detailed in the

note upon the preceding paper, "Occurrence of Magnetite in certain Minerals and Rocks," it appears—

1. That native sesquioxide of iron and its hydrates, such as hæmatite, gœthite, limonite, &c. are themselves non-magnetic, *i.e.* to an ordinary bar magnet, but may contain some magnetite.

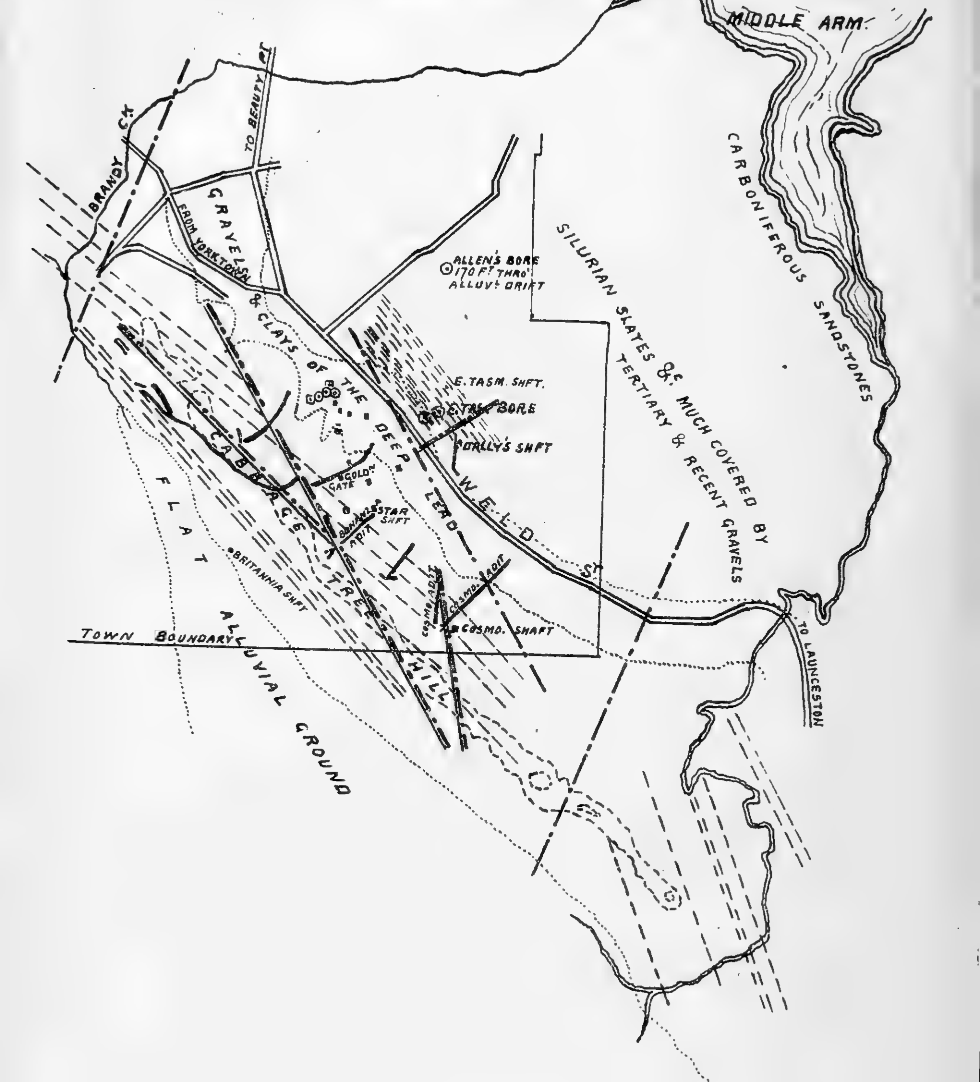
2. That sesquioxide of iron obtained by precipitation from the acid carbonate of iron and probably from other salts of iron is magnetic, or may be rendered magnetic by long boiling or by heating at various temperatures up to redness, and that such magnetic sesquioxide is free from any monoxide.

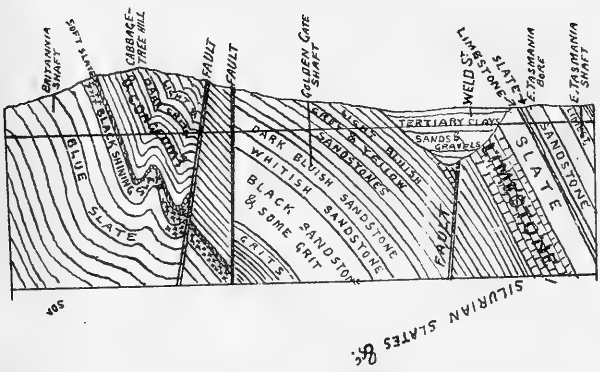
3. That magnetic sesquioxide of iron free from monoxide can be obtained by heating the magnetic oxide, as first shown by Robbins.

4. That ordinary rust produced by the oxidation of *metallic* iron is usually magnetic, and often polar. Magnetic rust usually contains more or less ferrous oxide, and may accordingly be regarded as x FeO, y Fe_2O_3, *i.e.*, varying mixtures of FeO and Fe_2O_3, and of their hydrates, being well known to possess magnetic properties, although in other cases the rust may be quite free from monoxide and yet be magnetic.

BEACONSFIELD & NEIGHBORHOOD

ILLUSTRATING PAPER BY MESSRS. MONTGOMERY & WARD





Section across Cabbage Tree Hill

ON LINE OF GOLDEN GATE & EAST TASMANIA SHAFTS

SCALE 1 2 4 6 8 10 12 CHAINS

Section C.

GEOLOGY AND PALÆONTOLOGY.

President of the Section:

T. W. EDGEWORTH DAVID, B.A., F.G.S., *Professor of Geology and Physical Geography, University of Sydney, N.S.W.*

1.—NOTES ON A CARBONACEOUS DEPOSIT IN SILURIAN STRATA AT BEACONSFIELD, TASMANIA.

By A. MONTGOMERY, *M.A., Government Geologist, and* W. F. WARD, *A.R.S.M., Government Analyst of Tasmania.*

(Plan and Section.)

We have the honour to bring under the notice of the Section the occurrence under unusual circumstances of a carbonaceous deposit in the Beaconsfield Goldfield, in strata of Lower Silurian or perhaps Cambrian Age. Lest the title of our paper should be misleading, we may at once say that the substance itself is probably not older than the Tertiary, being lignite or closely allied thereto, and that the interest attaching to it i that of the fly in amber—we wonder how it got there. The peculiarity of the occurrence is that a lignite should be found in the heart of a hill composed solely of very ancient grits and sandstones. When first discovered, and previous to its being analysed, the most likely theory of its origin seemed to be that it was derived from vegetable matter laid down among the sediments, which afterwards became hardened into grits and sandstones; that it was, in short, a Silurian coal. This erroneous idea was at once dispelled when analysis proved that it had the same composition as many lignites, and, as all well-established facts as to the origin of coal are against the possibility of a lignite existing in strata of such immense age, another explanation had to be looked for to account for it. This, we think, we have been able to find satisfactorily; and, though the deposit does not possess the great interest that would attach to it if it had been in very truth a Silurian coal, however impure, yet it shows an unexpected mode of occurrence of carbonaceous matter that is worthy of notice, particularly on account of the proof that it affords of the occasional presence at considerable depths

below the surface, of waters highly charged with organic matter,—a fact of great moment in accounting for the formation of metallic sulphides and other minerals.

In order to make clear the circumstances in which this substance is found, it will be necessary to give a brief description of some of the topographical and geological features of the district. To illustrate these the map and section will be useful. The most prominent natural object is a long narrow ridge, known as the "Cabbage-tree Hill," which rises to a height of from 350 to 450 feet above sea level. In this the principal mines are situated. It is composed of highly-inclined strata, the succession of which from below upwards is seen in the section,—viz., Slate, dark graphitic slate, dark grits and conglomerates, lighter grits and conglomerates, dark dense sandstone, light grey and whitish sandstone, bluish dark sandstone, thin-bedded yellowish and whitish sandstones passing upwards into slates, and, finally, a succession of beds of slates, sandstones, and crystalline limestones. Throughout the whole section there is a general dip to the north-east; but just under the crown of the hill the strata are thrown into several small synclinal and anticlinal folds, as shown. From the eastern base of the hill the ground slopes gently to the Middle Arm of the estuary of the Tamar. Along this base runs a "deep lead" or ancient river channel, which has been determined by the evidence of the fossil flora contained somewhat abundantly in it to be of Early Tertiary Age. The bottom of this old channel has been found by borings and shafts to be some 270 feet below the present level of the sea. The plain between the Cabbage-tree Hill and the Tamar is covered with varying depths of gravels of Tertiary and Recent Age.

On the south side of the Hill lies an extensive alluvial flat, which most probably is the site of an ancient lake that has partly been filled up and partly drained by the erosion of the gorge of the Middle Arm Creek. Some of this ground has been prospected for gold, and found to be very deep. The former existence of a lake here has probably had a great deal to do with the lignite deposits under discussion, as will be seen later on.

Two main lines of quartz reef traverse the Cabbage-tree Hill, one being that worked in the "Tasmania" mine, the other in the "Amalgamated West Tasmania," "Moonlight," "Olive Branch," and "Little Wonder." It is in the workings

of these that the lignite has been encountered. It was first found in the No. 5 level of the Tasmania, a little west of the second or western "cross-course," one of two large faults that cut through the Tasmania reef. The strata in this part of the mine are very much disturbed, preserving no regular strike and dip, and being visibly greatly fractured and shaken. The lignite was here mostly found in sandy soft layers between hard beds of coarse grit, presenting the appearance of being contemporaneous with them. Early in 1891 the Moonlight Company began to drive eastward from their shaft at the 422 feet level, and had not gone many feet when the lignitic mineral was encountered in great abundance. The beds of grit in which it was found were quite similar to those in the Tasmania mine, and corresponded very well with them in their position, thus at first sight strongly corroborating the theory that the carbonaceous matter was in the beds from the beginning. But as work progressed it was found that it had also penetrated into cracks and joints in the beds, as well as being in loose sandy layers between them, and, indeed, was brighter and purer in these cracks than anywhere else. Sharp angular stones of grit were obtained, too, completely coated with the lignitic substance, and an examination of these showed that they had been hardened and fractured before it had been deposited. Inside these pieces of stone there was no sign of carbonaceous matter. In this company's workings, as in the Tasmania mine, the strata were very much shattered where the black substance was found.

This broken state of the country suggested the explanation that surface waters from a swamp might have found their way down into it, and gradually deposited the carbonaceous matter in the crevices and soft porous beds. The more this was examined the more feasible did it appear, until now we are convinced that it correctly explains the occurrence. The absence of lignite in the upper workings of the mines, which might seem an objection to the acceptance of this theory, is easily explained: if it ever existed there it would rapidly be oxidised and destroyed by the oxygen in the waters brought down from surface in comparatively recent times since the surface has assumed very much its present shape. The deeper parts of the deposit, being considerably below the permanent water level of the district, have been protected from the influence of the atmosphere. In the Moonlight mine it occurs some 90 feet below the

present sea level, and at almost exactly the same depth in the Tasmania. When these mines first began to work the water level in them was considerably above that of the sea, and consequently the carbonaceous matter lay a long way below it.

Now, in Early Tertiary times the configuration of the country differed a good deal from its present aspect. To begin with, the land was probably at least 300 feet higher. This is proved by the fact that the bottom of the "deep lead" is 270 feet below present sea level, which can only be explained by a subsidence of the land. At the same period the Cabbage-tree Hill was doubtless connected with the Blue Tier Range at its eastern end, and at the western one had not been eaten into to its present extent by the Brandy Creek. The alluvial flat lying to the south was most likely occupied by a lake. As the top of the existing flat is about 400 feet above the bottom of the old lead, it is no improbable assumption to make that the waters of the lake stood at a much higher level than the old lead. Consequently, if any fractures and crevices existed in the hill separating them, there would be a possibility of leakage from the lake through the hill. Swamp waters and decaying vegetable matter might thus have got far into the ground. The subsequent subsidence of the whole countryside, which has resulted in sinking the old river channel far below sea level, would tend to preserve any carbonaceous matter thus brought in by covering it with water.

Objection may be taken to the assumption that the strata could be so porous as to permit of the passage of water carrying such quantities of peaty substance as are required to account for the large amounts of carbonaceous matter now found in the country. But when we consider that the lignite is found in the most broken part of the whole formation, where it has been crumpled into short folds, fractured by numerous cracks which have since become lines of quartz reefs, dislocated by two main and several smaller faults, and doubtless further disturbed by the recent movements of elevation and subsidence to which the whole district has been subjected, it is seen that unusual facilities would doubtless be afforded for the passage of subterranean waters. Here and there in the mines we come upon examples of free passage of water through the broken rock. In one of the branches of the West Tasmania reef the workmen followed blocks and strings of quartz which were interspersed through

a large quantity of broken country rock, filling a somewhat wide lode channel. In places great holes were found still existing between the fallen blocks, and in many of these loose gravel and sand derived from the disintegration of the softer conglomerates were lying, evidently carried there by subterranean waters flowing with some velocity. In the western end of the Tasmania mine a somewhat similar state of things occurs. One of the underground captains, in describing the condition of the country, said that the rock appeared just as if it had been blown up by a heavy explosion of powder and allowed to settle down again. As already remarked, this fractured state of the ground is very apparent in both the places where the carbonaceous matter has been found, it being generally impossible to obtain either the strike or dip of the strata with any certainty. In other parts of the workings where undisturbed country is gone through the strike and dip are very regular and easily measured. Even in these, however, it has been shown by mining works that water percolates with unusual rapidity and ease. For example, when a diamond-drill bore was being put down in the Phœnix Company's section, about 150 feet away from the nearest workings of the adjacent Tasmania mine, it was found impossible to keep the bore full of water, even with two pumps constantly throwing it in, and this, too, when the bottom of the bore was nearly 250 feet below the level of the water in the mine, and when it was tubed down all the way. The water escaped through the porous jointy rock at the bottom of the bore faster than it could be poured in, and none of the usual expedients for closing the interstices in the strata were of the slightest use. The same difficulty was experienced in getting the water to the surface in another diamond-drill bore, executed by the East Tasmania Company, which was distant about 840 feet from the Tasmania mine workings, even when at a depth of 400 feet below these, and with the bore tubed throughout. The Tasmania mine is, in fact, now draining the whole district for a long distance round, numerous wells and springs which were formerly permanent having gone dry since the pumps began to work. The shafts of the West Tasmania, Moonlight, and Little Wonder Companies are down some 90 feet below sea level, yet are usually quite dry, any water that gathers in them in wet weather draining away through the ground. Some months ago when, owing to various causes, the lower levels of the Tasmania mine were flooded,

water gradually rose in the Moonlight shaft, but subsided again as the former mine again became unwatered.

These instances, and numerous others that could be cited, show the great ease with which at the present day water passes through the rocks of this district, and it is reasonable to suppose that in Early Tertiary times it would be similarly easy, and that there would be no great difficulty in the way of very considerable quantities of fine peaty sludge being carried down into the crevices and more broken parts of the ground by water seeking a natural outlet.

Coming now to the chemical and physical properties of the carbonaceous substance, we find that it comes nearer to lignite or brown coal than to anything else. It is from brownish black to pitch black in colour, soft, pulverulent and earthy to coherent and brightly lustrous, with brownish dark streak, and specific gravity slightly greater than that of water. Much of it has a finely banded structure, alternate layers being bright black and brownish earthy, slightly suggesting a woody structure at a first glance.

The average composition was found by analysis to be as follows :—

	Per cent.
Carbon	38·91
Hydrogen	3·03
Oxygen and Nitrogen, by difference	21·60
Sulphur	2·36
Ash	12·00
Moisture lost at 100° C.	22·10
	100·00

Another analysis of some of the material that was found as a coating on pieces of the hard grit, which had evidently been completely hardened into rock before its deposition, gave the following results :—

	Per cent.
Carbon	34·73
Hydrogen	2·73
Oxygen and Nitrogen, by difference	22·09
Sulphur (as above)	2·36
Ash	18·33
Moisture lost at 100° C.	19·76
	100·00

The loss on ignition in a closed vessel amounts to about 75 per cent., but the gases driven off give but little flame,

and the residue is black and powdery. More than one-half of the ash consists of sulphate of lime, the other main constituents being silica, alumina, and oxide of iron. Caustic potash acts strongly on this substance, but alcohol and ether have little or no effect.

From the composition and physical properties it is clear that this substance is a variety of brown coal. The banded structure above referred to as occasionally visible is probably due to the deposition of peaty matter in successive layers rather than to actual woody structure. The high percentage of sulphate of lime in the ash is of interest, and points to the theory brought forward above being correct, as this salt is frequently deposited from infiltrating waters.

No microscopic examination either of the raw brown coal or of its ash has yet been made. Both would be interesting, the former to show if any traces of vegetable tissue still survive, and the latter to show the presence or absence of waterworn material.

In conclusion, we would remark that this history of a comparatively modern deposit of brown coal in the middle of a hill of very old rocks may explain the occasional occurrences that have been at various times reported of anthracite and graphite in reefs of quartz and their casings. Doubtless in course of time, if circumstances were favourable, this, too, would become more thoroughly carbonised. The quantity of carbonaceous matter present in this instance is, however, we believe, much larger than has ever been recorded in any similar circumstances, as it is to be reckoned by tons and not by stray pieces. So much of it is distributed through portions of the rock that there is little doubt that the whole mass excavated from the Moonlight Company's drive would smoulder for weeks if once properly set on fire.

2.—ON A SAMPLE OF CONE-IN-CONE STRUCTURE, FOUND AT PICTON, NEW SOUTH WALES.

By A. J. SACH, *F.C.S.*

The so-called cone-in-cone structure, which appears to be found in most countries, and which consists either of impure carbonate of lime or, less frequently, of impure carbonate of iron, still awaits a satisfactory explanation as to its mode of formation. It is more for the sake of eliciting the opinions of the geologists now assembled than of advancing any

theory of my own that I exhibit the present specimen and offer a few remarks on its composition and structure.

Out of some half-dozen of geological text-books that I consulted in the public libraries of Sydney, that by Archibald Geikie, F.R.S., is the only one containing a reference to the cone-in-cone structure. Geikie appears to adopt the opinion of Professor Marsh, who states that the complex structure known as cone-in-cone may be due to the action of pressure upon concretions in the course of formation.

H. C. Sorby, F.R.S., in a paper read before the British Association, 1859, stated that he had examined transparent sections of the structure with a low magnifying power under polarized light, and concluded that it was intimately connected with some kind of oolitic grains, which have crystals of calcium carbonate deposited almost entirely on one side along the axis of the cones in such a fan-shaped manner as to give rise to their conical shape. He states his conviction that the structure is one of the peculiar form of concretions formed after the deposition of the rock in which they occur by the crystallisation of the calcium carbonate and other isomorphous bases.

Dr. Dawson, in his Acadian Geology, 1868, asserts that the structure is produced by concretionary action proceeding from the surface of a bed or layer, and modified by gradual compression of the material.

R. Daintree, F.G.S., Quarterly Journal of Geological Society, Vol. XXVIII., 1872, says that the structure has more of the appearance of a chemical precipitate than of a mechanical deposit.

John Young, F.C.S.S., Transactions of the Geological Society of Glasgow, Vol. VIII., read a paper on the subject in 1885. He possessed evidence that the band of cone-in-cone structure, which he described, rested on a clay-band ironstone, and that it was on the same horizon as a bed of stratified shale composed in bulk of calcareous shells of entomostraca, of species frequenting lacustrine waters. He possessed many samples of the mineral which had been found in Scotland, and none had been associated with marine deposits. After careful examination he concluded that the cone-in-cone structure is the result of a mechanical action set up by chemical agencies generated in the stratum, and whilst the deposition of the sediment was going on. The chemical agencies were the outward and upward escape of gases generated by the decomposition of organic matter in

the deposit; the gases, as they escaped through the oozy and plastic mud, elevated the sediment around the several points of eruption into ring-like layers.

The sample which I now exhibit occurs at Picton, New South Wales, in the upper course of the Picton Creek, which traverses a valley locally known as Glenforsa. The hills on either side are well-grassed slopes of Wianamatta shales, which are of Triassic Age, and are generally considered of fresh-water origin. I do not know of any extensive shell-beds or other lime deposit found in the shales, but when traversing the glen some irregular nodules of calcium carbonate were picked out of the banks of the creek. The cone-in cone mineral occurs as a horizontal layer, which is exposed at the bed of the creek, but passes under the adjoining bank. So far as I could learn, it is not now in process of formation. The thickness is about two inches, composed entirely of cones within cones closely packed together. It has been asserted that in some European specimens the apices of the cones point both upward and downward, but in the specimen now under consideration all apices point downward. The open bases of the cones, formed of amphitheatre-like cavities, are about half an inch in diameter, and small ones are sometimes formed within the larger ones. The chemical composition of the specimen is, approximately—Calcium carbonate, 67·54 per cent.; matter insoluble in strong hydrochloric acid, 21·2; sesquioxide of iron, 4·14; magnesium carbonate, ·7; water, 3·1. In some parts the mineral is distinctly crystalline, and, in my opinion, a purely mechanical origin can scarcely be entertained. It appears to be a chemical precipitate which has resulted in imperfect or disguised crystallisation. The floor crystallisations, known as "crystal cities," at the Jenolan Caves, N.S.W., have a somewhat similar external form. The mineral might have been formed in the drying up of the calcareous waters of a lake.

3.—NOTES ON SOME OF THE ADVANTAGES OF A FEDERAL SCHOOL OF MINES FOR AUSTRALASIA.

By JOHN PROVIS.

The economic development of the mining and metallurgical industries of these Colonies is so intimately related to their future prosperity that I am induced to offer a few suggestions

on the above subject, in the hope that it may lead to its further discussion and ventilation.

That the mining schools now in existence in the Colonies have not yet attained to the same degree of efficient teaching as the leading schools of Europe and the United States will, I think, be admitted by most people; and under existing circumstances, when the population of our senior Colony only slightly exceeds one million, it is scarcely to be expected that any one Colony should bear the expense necessarily attached to the efficient maintenance of a first-class School of Mines, with its well-appointed mining laboratory and talented staff of professors.

At the same time, these schools have done, and are still doing, good work, and could be made more useful by the extension of mining classes and delivering series of lectures on mining and its allied sciences in the various mining centres outside the localities where the existing schools are situated.

Of course, a well-appointed mining laboratory would mean the proper equipment of plant whereby parcels of ore of from 500 lbs. to 5 tons could be treated by the various processes of concentration or reduction, and thus be something of a scale of 12 inches to the foot in relation to its commercial treatment.

A central Federal School of Mines, where more advanced students could complete their studies, or go in for a three or four years' course of thorough practical and theoretical training, is much to be desired; and if the same school could also be utilised as headquarters for the dissemination of information and instruction in mining and its allied sciences, under whose auspices mining and scientific classes could be conducted in most of our larger mining centres, and yearly examinations held something after the same admirable manner as the May Examinations in connexion with the Department of Science and Art at South Kensington, it would at once establish a powerful and efficient medium for scientific instruction, and through its examinations indicate the standard of proficiency attained, whether in the elementary, advanced, or honors stage.

It may be urged by some that we have not the advantages for the acquisition of practical instruction possessed by some European mining schools, and that mining and metallurgical operations are far more efficiently practised in Europe than in Australia.

In regard to our advantages, I think they would be better than those possessed by most European schools.

A centrally-established Federal School would be within forty-eight hours of gold, silver, copper, tin, and coal mines. In each of these important mining centres operations are conducted with skill and economy, and will bear favourable comparison with similar operations in most parts of the world. Take, as examples, the admirable system of tin-ore dressing at Mount Bischoff, the system of mining large bodies of ore at Broken Hill and smelting the same, or the cheap methods of working coal in some of our best Newcastle mines, or the profitable extraction of gold from very low-grade quartz in Victoria. All these afford splendid opportunities for the acquirement of practical knowledge.

There is no doubt that many metallurgical operations are more successfully carried out in Europe, but this is largely owing to a ready local demand for bye products and very low rate of wages, thus affording opportunities for the profitable treatment of much poorer ores than can at present be done in these Colonies.

Among other important advantages that could be enumerated would be the better working of our mines and works by properly trained, qualified men; consequently, fewer failures.

Not that I think that such a school would turn out perfect mining engineers or metallurgists. The completion of the training can only be acquired at the furnace, mill, or mine. But a well-trained student will the more readily adapt himself to his circumstances, and be the better engineer for his studies.

There may be many difficulties to encounter before such an establishment may become an accomplished fact; but I feel confident that when its advantages are fully recognised, the Australasian people, actuated by a common desire for the common welfare, will prove superior to every obstacle, and mining and metallurgy will develop into larger and more important factors in the prosperity of these Colonies than has ever yet been recorded in their history, when the Federal School students have proved themselves skilled workers.

4.—ON THE OCCURRENCE OF *LEPIDODENDRON* NEAR BATHURST, N.S.W.

By W. J. CLUNIES ROSS, B.Sc., F.G.S., &c.

During last year two fossils were brought to me in Bathurst which, I think, are of sufficient interest to be worth bringing under the notice of the members of this Section. Both are fossil plants belonging to the genus *Lepidodendron*—of the exact species I am not sure—probably *Lepidodendron nothum* or *Lepidodendron australe* ; but of this I shall have more to say presently. The importance or otherwise of a fossil of course largely depends on the conditions under which it has been found, the rocks from which it has been derived, whether it was previously unknown in those rocks, and, if so, whether its occurrence in them tends to throw any definite light on their age, if this was previously uncertain, or to alter an opinion of their age previously entertained.

I propose, in the first place, to speak of the way in which the fossils came into my possession. The first of them was picked up in the streets of Bathurst, having evidently been carted from the bed of the present Macquarie River in a load of gravel for mending the roads. It is only a rolled stone and therefore might be thought to be of no value to a geologist except as a mere specimen of an interesting fossil. In some cases however a rolled stone may be valuable, and in the present case it has clearly been brought down by the river and has therefore been derived from the upper part of the river course. The Macquarie is formed by the junction of the Fish and Campbell rivers about six miles above Bathurst. From which of these two rivers the specimen came I am not certain, probably the Fish. Neither river however has a very long course, and neither, so far as I am aware, flows over any rocks newer than the Devonian, so that the specimen is likely to be of the latter age. It is therefore of some interest; nevertheless, its origin is too uncertain to be worth calling special attention to except as having some bearing on the other specimen. This was found in a locality with which I am very well acquainted, about ten miles east of Bathurst, by the son of a well-known Bathurst resident, Mr. T. Atkins, who noticed it incidentally and brought it in to me. I at once recognised it as a *Lepidodendron*, and made up my mind to visit the locality on the earliest opportunity to endeavour to procure some other specimens, and

determine the exact bed from which it was derived. In company with Mr. Atkins I visited the place where the fossil was found, and spent several hours in carefully going over the ground and examining the rocks, but could not find another specimen. I found however several beds of rock very much alike, from one of which I am tolerably confident it was derived, but the exact bed is of little importance, since they are all apparently conformable and of similar age.

What is that age? we may next ask. To answer the question it is necessary to briefly describe the geology of the surrounding country. As we proceed eastward from Bathurst, we pass off the granite on which the city is built at about seven or eight miles from town. The rocks first reached are soft shales, passing into crystalline schists or hornfels in the immediate neighbourhood of the junction with the granite. The schists are much tilted and last for about three miles. Beyond them, still proceeding eastward, we reach a series of beds of quartzite, red and brown grits, in many cases containing casts of *Brachiopods*, and occasionally corals, with intrusive rocks coming in at intervals and apparently interbedded with the grits and quartzites. It is from one of the grit beds that the fossil *Lepidodendron* appears to have come. The soft schists are usually classed as Silurian, and on the geological sketch map published by the Mines Department of New South Wales a broad band is coloured as belonging to that system, so that it would include the whole series of grits, &c. as well. I believe, however, that the late Mr. C. S. Wilkinson, F.G.S., whose recent death must be deplored by all Colonial geologists as a distinct loss to the science, classed the gritty beds containing *Spirifer disjunctus* and *Rhynchonella pleurodon* as Siluro-Devonian, and they are very probably of Devonian Age. The beds themselves never appear to have been carefully studied, and in fact the only example of systematic stratigraphical work in the district with which I am acquainted is that done by Mr. Wilkinson himself, who surveyed the country around Lithgow and Rydal, and compiled a geological map and section which appeared in the Report of the New South Wales Department of Mines for 1877. The map is an excellent piece of work, and there are a few notes attached to it, but unfortunately the author does not seem to have published any detailed memoir upon it, so that we can only refer to the map itself, the section, and a short account in Mr. Wilkinson's "Notes on the Geology of New South Wales," also

published by the Mines Department, for information on the geology of that part of the country.

In the section the Carboniferous rocks of Lithgow and the surrounding district are shown to consist of two divisions—the upper coal-bearing series, probably the same age as the Newcastle beds, and a lower division, including the so-called Upper Marine and Lower Coal Measures. They rest partly on granite and partly on the underlying Devonian beds, to the latter of which they are quite unconformable, the dip of the Carboniferous being given as about 5°, while that of the Devonian is given as about 30°. The Devonians are folded on a large scale, and the section shows a fine synclinal between Mount Walker and Rydal. The total thickness of the beds is stated to be 10,000 feet by measurement. The section is continued to Mount Lambie, whence to the locality with which we are concerned in this paper there is a gap of fully sixteen miles in a straight line, concerning which I can find nothing published. At a few places along the line I have been able to examine the rocks, but do not find any marked difference from the Devonian beds described by Mr. Wilkinson except in the neighbourhood of mineral veins, while the fossils in the gritty beds already mentioned are the same as some of those quoted from the Devonian at Rydal as having been named by Professor De Koninck. It appears therefore likely that the Devonian beds extend from east of Rydal on the Western Railway Line to within ten or twelve miles of Bathurst. They appear generally to terminate in a bold escarpment. At the place where the Lepidodendron was found this is especially well marked. It is a narrow valley, almost a gorge, down which a small stream runs. The sides are very steep, and the beds which form them—grits, quartzites, &c.—dip eastward. There has been a good deal of slipping in the rocks, and the dip appears to vary in amount, but is nowhere greater than 30° so far as I have been able to determine it. On proceeding up the stream from where it joins the Wimburndale Creek for a mile or two, one reaches a small waterfall formed by a ledge of quartzite. Above this the valley becomes steeper, but there is no important change in the rocks until a double series of falls, forming the head of the valley, is reached. The upper and largest of the three is due to a thick and very massive conglomerate, which forms the summit of the escarpment. At the side of the valley near the upper fall there is a distinct fold, and the beds for a short distance dip west. I

believe this is merely a local change, but it agrees with the character of the beds at Rydal. The total rise from the valley to the top of the upper fall is over 1000 feet.

I have personally no doubt that the *Lepidodendron* came from one of the beds at the side of the short valley, as they are of almost precisely similar character to the matrix of the fossil, and in them I found faint indications of vegetable remains, but not sufficiently definite to admit of identification, while the fossil itself has not been rolled.

Now, as to its geological significance. There are two species of *Lepidodendron* mentioned in Dr. Feistmantel's work [1] on the fossil plants of Australia as occurring in rocks of Lower Carboniferous or Devonian Age. These are *Lepidodendron nothum* (Unger) and *Lepidodendron australe* (M'Coy). The former is stated to occur at several localities in Queensland; also at Goonoo-Goonoo, Cowra, Canowindra, and Mount Lambie, near Rydal, New South Wales. It is a European Devonian species, and the beds in which it occurs are classed by Dr. Feistmantel as also Devonian. *L. australe*, on the other hand, is a Victorian species and is classed as Lower Carboniferous.

In connection with the account of *L. nothum*, however, a notice is inserted by Mr. R. Etheridge, jun., in which he questions the occurrence of that fossil in Australia, his words being: "The evidence *at present* existing of the latter (*L. nothum*) having existed in Australia in bygone times is of the weakest." He considers that the fossils identified by Mr. Carruthers, of the British Museum, as *L. nothum* to be probably identical with *L. australe*. In this view he states that Professor M'Coy and Mr. R. Kidston agree with him, so that it appears there is a difference of opinion on the matter—Mr. Carruthers and Dr. Feistmantel, who agrees with him, on the one side, and Messrs. Etheridge, M'Coy, and Kidston on the other.

As to whether our fossil should be called *Lepidodendron nothum* or *L. australe* I do not pretend to say. When such able palæontologists differ it would be presumption for me to express an opinion. Nor do I think the exact name of the species is of much importance, although its stratigraphical position is, I consider, very important. For if *L.*

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[1] Geological and Palæontological relations of the Coal and Plant-bearing Beds of Palæozoic and Mesozoic Age in Eastern Australia and Tasmania: by Ottokar Feistmantel, M.D., &c. Sydney: C. Potter, Government Printer, 1890.

nothum does not occur in Australia and *L. australe* is a purely carboniferous form, then the beds in New South Wales, Queensland, and Victoria containing any Lepidodendron must be considered not older than Carboniferous. Now, Dr. Feistmantel states that the Rev. W. B. Clarke found *L. nothum* at Mount Lambie, *in situ*, below the level of the Brachiopod sandstone of the same locality, thus proving that it belonged to the Devonian series. Mr. Etheridge states, however, in another note, that the expression " below the level " was misunderstood by Dr. Feistmantel—that it must not be taken in a stratigraphical sense, but merely referred to the conformation of the ground, and that the *Lepidodendron* in question occurs in beds stratigraphically *above* the Brachiopod sandstone. He is supported in this by Mr. Wilkinson's notes. The fossil from near Bathurst almost certainly came from the Brachiopod sandstone, and as these can hardly be younger than Devonian it appears to confirm Dr. Feistmantel's view, or, at any rate, to show that *a Lepidodendron* is found in Devonian rocks. Its importance appears to me to consist in this :—1st. It shows that the Devonian rocks of New South Wales covered a much more extensive area than they are shown to do on the sketch map, and it will help to decide the question as to whether a very extensive series of rocks should be classed as Silurian or Devonian. 2ndly. If this fossil be identified as *Lepidodendron australe*, then I think we must admit that that form is not confined to the Carboniferous.

It may be said, however, that the fossil is possibly derived from some carboniferous bed. In that case we have this remarkable state of things : there must be a great break in a series of rocks, but quite unrecognisable by any stratigraphical break, and we pass from Devonian, probably Lower Devonian, to Carboniferous without even a change in the petrographical character of the rocks, since there are no signs of an unconformity and the grits and sandstones are so much alike as to appear identical.

This may be the case ; but if it be, it will to a large extent revolutionise the geology of a great part of New South Wales. Hitherto it is at any rate doubtful, I believe, if *L. australe* has been found in the Colony ; but there are two species of *Lepidodendron*, which occur at Smith's Creek near Stroud, in beds which are considered to be Lower Carboniferous, being associated with marine fossils of that age. These species are *L. volkmannianum* and *L.*

veltheimianium, both of which appear to belong to the Lower Carboniferous of Europe. Neither of these species has been found in the rocks of Mount Lambie nor in any of those considered to be of Devonian Age, so that it would appear that they are characteristic of a higher horizon, and if that be Lower Carboniferous then it becomes almost certain that *L. nothum* or *L. australe*, if our fossil belongs to the latter, is Devonian in New South Wales at any rate.

The questions involved are not only important in New South Wales geology. The age of many of the Queensland beds is still somewhat uncertain, and *Lepidodendron australe* occurs there as well as in Victoria, and one of the most desirable things in Colonial geology is to obtain a satisfactory correlation between the older beds of the various Colonies, especially those of Tasmania, Victoria, New South Wales, and Queensland. In Mr. R. L. Jack's "Handbook of Queensland Geology" *Lepidodendron* is mentioned as occurring in the Star and Gympie beds. The species is quoted as *L. nothum*, but is said to be identical with *L. australe*, so that Mr. Jack evidently agrees with Mr. Etheridge, jun., in the matter of the species.

While this paper was in course of preparation I received from Rev. J. M. Curran, F.G.S., a copy of his book on "The Geology and Petrography of Bathurst," being the substance of a paper read by him before the Linnæan Society of New South Wales. In this allusion is made to the stratified rocks to the east of Bathurst, and the names of a few fossils from limestones believed to be Silurian are given, but this part of the subject is only briefly treated, so that nothing definite as to the age of the other rocks can be deduced from his work.

5.—NOTES ON THE LATE LANDSLIP IN THE DANDENONG RANGES, VICTORIA.

By F. DANVERS-POWER, F.G.S.

The tenth, eleventh, and twelfth of July, 1891, will long be remembered in Victoria as the dates on which one of the most destructive floods occurred that has taken place since that colony has been inhabited by Europeans. This unusual deluge of rain brings before us most vividly the action of disintegrating agents around us; the results of these that are most prominently brought to our notice at the south-west

portion of the Dandenong Ranges are the frequent landslips that have taken place there. These ranges run N.E. and S.W., but at the south-west end turn up towards the N.W. Landslips are by no means uncommon in this district, traces of them can be seen all along the mountain's side for about five miles in a north-east and south-west line. A little to the west of the present slip one of nearly equal magnitude took place in the year 1863, at which time various minor slips were also formed, including one which has lately developed into the largest of the season. When seen from a distance the main slip looks larger than it really is, as one cannot distinguish readily the talus from the slip proper, the whole forming a brick-red coloured blot on the mountain side, looking like a large ploughed field.

On each side of the house occupied by Mr. Sydney Ellery runs a creek: these are tributaries of the Olinda Creek, and have their sources in springs on the side of the mountain. On Sunday, 12th July, about 1·30 P.M., these creeks, which had been gradually increasing in volume and turbidness for some days, suddenly burst their bounds and came roaring down like a river in flood, spreading out four hundred and seventy feet in width. This continued for some three hours, when the main slip suddenly took place (preceded by a rumbling noise), which shifted nearly an acre of land in area, and a volume equal to thirty-five thousand cubic yards, leaving a fall eighty feet deep. The upper part of this slip is five hundred feet above the creek below, and is more than half way up the ridge on which it is situated. The *débris* rushed down the side of the hill, which lies at an angle of thirty degrees, across the creek, up a neighbouring spur in a north-west direction for two hundred and fifty feet in horizontal length and thirty feet vertical height, with such force that blocks of stone weighing over a hundredweight were carried up. The impetus being thus checked, the slurry was then diverted in a northerly direction back again into the creek, but this being soon choked up with *débris*, a fresh course was carved out by the moving mass. Large stringy-bark trees, broken off short, were spread like spillekins about the ground, and large boulders were hurled along, carrying away fences in their course; the combined forces of the *débris* throwing themselves against the dwelling-house of Mrs. Heutell, raised it from the ground, the sticks and stones covering acres of good land.

The landslips that have taken place here may be classified into deep-seated and surface slips, and the latter into those

that have quietly slid down *en masse* without disturbing the vegetation growing on them, and those broken up anyhow: further, we may distinguish between those caused by water and those subsidiary ones due to their lower support having been removed; a series of these eat back into the hill like a waterfall scooping out a gully.

The chief slip took place in Mr. Robert Singleton's paddock, at the back of Mr. Sydney Ellery's residence, which stands on a spur, probably the remnants of a former slip. Several lesser slips took place at frequent intervals during the heavy rains, and still continue when there is much wet weather. On the east, and close to the main slip, are two minor ones; the foremost has dropped ten feet bodily, and so gently as not to disturb the large trees growing on it; that at the back, being on steeper ground, is more broken up. In these minor slips, which are mostly confined to the surface soil and a few floating boulders, the trees play a great part. Sometimes by falling they start a slip, but more frequently by binding the earth together they serve to retard the motion of the soil at the back of them. Even in the case of the large slips, trees are to be found growing erect on the edge of a precipice, which leads one to suppose that they have assisted in determining the line of slip. The slips invariably take a horseshoe form, as the rock breaking away at the weakest point drags away the land at its sides as it sinks down to form a terrace, leaving a natural quarry behind. The country rock is diorite porphyrite, consisting of a greenish grey felspar matrix, thickly studded with crystals of oligoclase, and, occasionally, bebs of quartz, flakes of magnesian mica or crystals of hornblende, and containing iron pyrites as an accessory mineral; in fact, the varieties pass from plagioclase porphyrite into mica and hornblende porphyrite, the whole weathering grey. The soil above this rock is a reddish clay two feet thick. Data to hand is not sufficient to enable us to judge what influence terrestrial movements, in the mountain-building sense, has had in causing these slips, but it is evident that the main cause is due to the jointed nature of the rock, enlarged in many cases by the roots of the vegetation growing on the surface, and wedged open by particles of earth falling in the crevices. Water, with its gases, salts, and acids in solution travelling along these natural water channels have attacked the felspathic minerals, forming clay and other secondary minerals: these, while endeavouring to exfoliate, will also exert great

force, and at the same time act as a lubricant to the blocks of stone. The cohesion of the rock being thus brought to the lowest possible pitch, it requires but the starting force to enable it to continue the motion down hill, the sides of which are too steep for the loose mass to rest on. The numerous cracks and joints collect an immense quantity of water, which being dammed back by the clay result in springs which are the sources of the creeks. Years of slow chemical action prepared the rock for its final dislodgement; the unusual pressure of water, owing to the great rains, soaked the ground and started the mass moving, the weight of the superincumbent material on an incline doing the rest; the more or less rotten boulders knocking up against one another provided the slurry and *debris* that has, for the time being, ruined some acres of lower-lying land, the quantity of rotten rock showing the extent of decomposition the hill has been subject to. The land having been loosened and removed its locality is drained, but where the water is stagnant evidences of chemical action are still to be seen in the ochreous deposits, the smell of sulphuretted hydrogen and the iridescene on the surface of the pools due to minute crystals of iron pyrites.

6.—THE APPLICATION OF PHOTOGRAPHY TO GEOLOGICAL WORK.

By J. H. HARVEY.

In the paper under the above heading which the author read at the Melbourne meeting, the use of photography in connection with geology was pointed out, and the many branches of it which might be pressed into the service of the geologist were enlarged upon, one of the branches recommended being the practice of "stereoscopic work."

For giving a correct impression of irregular country and horizontal distances the value of the stereoscope cannot be over-estimated.

An ordinary flat photograph, the point of view of which has been well chosen, and the lighting of which has been carefully studied, gives a slight idea of the separation of the various horizontal planes; but a true rendering of this separation, such as would be apparent on a personal inspection, cannot possibly be obtained by the examination of anything but a stereograph.

Among the most interesting fossils which the author has

seen, some have differed so little in colour from the attached rock which formed the ground, that the representation of them by photography in the ordinary manner was most unsatisfactory. In many instances the natural irregularities of the surfaces of the object were of far greater value in assisting in the determination of it than the contour and markings defined by the local colour, and such objects when copied as stereographs were rendered in a much clearer manner.

The practical details of the photographing of some of the above, and of the systems of illumination and development adopted are most interesting. The working out of these and the results of the many experiments made in order to secure the best rendering of each specimen were also exceedingly instructive, but a description of them would scarcely lie within the province of a paper read in this Section, and, indeed, would be of little value without practical demonstrations, convenience and time for which do not exist.

Instances (such as the one quoted) in which the great use of the stereoscope is evident might be multiplied indefinitely, and in everyday work there are very few subjects which do not absolutely demand it; for this reason its value cannot well be made too prominent, and every geological photograph of natural scenery should be stereoscopic.

For those who object to the small size of the ordinary stereoscopic print the reflecting stereoscope is recommended, as the size of the prints which may be examined therein is limited only by convenience.

The photographing of all important rock sections which are exhibited by railway or other cuttings, or by landslips and excavations, as well as all fossils, should in most cases be executed as soon as possible after the excavations have been made or the fossils discovered; some of the latter begin to alter in appearance directly they are exposed, and many commence to decay or decompose very shortly after. Sections brought to light by excavations also often become completely changed by atmospheric and other influences very quickly, and the differences in colour of the various strata, though not always most marked when the surfaces are new, are very often so. Under any circumstances the first shower of rain introduces foreign matter, and otherwise alters the state of things.

In the paper read by the author at the Melbourne meeting an attempt was made to point out the lines upon which the

work should be done, so that it is unnecessary to traverse the ground again, and in order to illustrate practically the use which might be made of these records not only in everyday practice, but in publications and for lecture purposes, a series of typical views was shown by the aid of the optical lantern. These illustrated several of the geological periods, the views having been taken from actual Australian scenes, the large rock masses illustrating granites, porphyries, limestones, basalts, &c. being first shown, and following them were exhibited photographs of the polished surfaces of these same rocks, together with photo-micrographs of sections of them, giving upon the screen a magnification of 500 to 1500 times, thus rendering the series complete.

7.—MOUNT BISCHOFF.

By H. W. FERD. KAYSER, M.E.

THE history of Mount Bischoff as a tin-producing district began from the 4th December, 1871, as on that day Mr. James Smith, of River Forth, discovered tin ore at the slope of the Mount; and the first sample—a matchbox full—he took to the establishment of Messrs. Moore and Quiggin, at Table Cape, where he also met Mr. E. B. E. Walker, known as Dr. Walker all along the N.W. Coast, who undertook the smelting process. At this time no one knew what ore it was; but when the first button lay bright and shining before those present, the question was asked, "Is it silver?" which the old doctor, being an expert, soon settled. The full value of the discovery did not present itself to any of these gentlemen then, as no doubt they all would have liked silver in preference to tin.

In August, 1872, Mr. Smith, in company with Mr. W. M. Crosby and a small party of workmen, proceeded to Mount Bischoff, and opened a track to connect Knole Plain with the southern portion of the leased ground, and mining began on the 14th December of the same year.

In the middle of 1873 several tons of ore were sent to Melbourne, which caused a good deal of attention among mining men, and negotiations were entered into with a syndicate for the sale of the mine. To effect this Mr. Wm. Dick was selected to inspect and report upon the property. After the report had been received all appeared to go on well; but, singular to say, after a certain amount of business

had been transacted between the parties, all negotiations were abruptly broken off, and for some time everything in connection with this undertaking looked very disheartening. And no wonder. How was it possible that a single individual could undertake in those days to open up a mine 50 miles from the coast, with many miles of impenetrable scrub and heavily-timbered country intervening? All had to be accomplished with the axe and perseverance, and a certain amount of money, which was no easy task to find in those days. But even after that was effected, many other obstacles stared the pioneer in the face, which made it almost impossible to start an undertaking like this single-handed; and only with the help of others could he hope to succeed. At this particular time the discoverer of the tin ore at Bischoff got an introduction to Mr. W. Ritchie (subsequently and up to the present time a Director of the Mount Bischoff T.M. Co.), who was willing to undertake the floating of a company, provided the result of his visit, in company with other gentlemen, should prove satisfactory.

In August, 1873, the Mount Bischoff Tin Mining Company, Registered, was formed, in 12,000 shares at £5. 4400 paid-up shares and £1500 was the purchase price Mr. James Smith received for the mine, consisting of two 80-acre sections.

Work was started shortly after the formation of the Company, and Mr. W. M. Crosby was appointed the first mining manager.

The condition of the Company had to be made very liberal, on account of the depressed state of the Colonial money market at that time, and on that account it was decided to make only one call of 20*s.* per contributing share, and get the bank to advance the balance of the money required to open the mine. £15,000 was considered sufficient capital, and twelve months sufficient time to do all the work required, and hopes were held out that not only would all the money be paid back by that time, but also a small dividend. This, we all know at the present time, was only looking at the sunny side of the picture, but the difficulties followed soon. There was more hard work to be done than any one connected with the Company at that time could foresee. The main points had been overlooked, or not seriously considered. It was not only necessary to prepare a track or road from Emu Bay to the mine, and partly to clear the mine of the horizontal scrub and the heavy timber, but,

besides that, there were tramways to be constructed, also water-races and flumes, and these had to be connected with the reservoir in the river and the sheds. Ore-dressing appliances had also to be constructed to make the ore marketable. And who could finish all these works in the specified time? The task was a herculean one. Here were all the difficulties of pioneer life put together, and it was hard to decide which of these was the greatest.

The climate in those days was very wet, and it was nothing uncommon to have rain for a month or more without ceasing, and then only for a very short time. I have experienced in my own time 16 weeks' rain, only broken twice for a short period; and, without an almanac, no one could guess by the look of the sky what stage the moon was in. This in itself was enough to frighten a strong man; but, in addition to this, came the uncertainty of the food supply during the winter (lasting about 9 months), as pack-horses had to be depended upon for all supplies in those days, and these were very irregular, owing greatly to the almost impassable state of the road or track.

No mail service was established until March, 1875, or more than 2½ years after the mine was started, and it was only natural under such circumstances that the people at Bischoff expected every visitor to call at the Emu Bay Post Office for letters and papers. Any one neglecting this received a very indifferent reception; but, with the mail in his bag, the visitor was treated like a prince on bacon and damper and other delicacies kept in the camp in those days. One comfort they had, and that was plenty of firewood, and the horrible horizontal scrub turned out to be, in this respect, the best friend, as this wood burns almost better green than dry. As time rolled on it became apparent that a mine of this description, and with so many drawbacks, could not be opened in 12 months and with the capital first estimated.

Shortly after the Bischoff Company started work, the Stanhope Company (then known by the name of Walker and Beecroft) and the Old Dan Company started almost simultaneously, and, as all these Companies had common interest in certain works, they came to an understanding to assist one another and work in harmony where it proved beneficial to all parties. Under this system the tramway between Waratah and the mines was constructed, the building of the reservoir in the river, and connecting this

with the machine sites by race and flume ; also, spending a large amount of money (£10,000) in the formation of a road between Emu Bay and the mines, particularly through the Nine-mile Forest, where the foliage was so dense that sun-light could not reach the ground, even at mid-day. All this was a heavy drag upon the shareholders of the respective Companies. But now what a change has come over the scene ! At the West Coast and elsewhere where mining is started everything must be done by the Government, and, if not done quick enough, strong language is used.

This remark I make only in passing to show the difference in the times, and I think the Bischoff Company's directors and shareholders ought to feel proud in knowing that all they got was through their own pluck and perseverance, and not through any Government coddling. Indeed, the district never received fair play from any Government, and I do not think the same expression as applied to this locality has ever been used to any Company outside of Bischoff when asking for assistance—viz., "You are rich enough to help yourselves."

No Government road fit for use is in existence to the present day, after having worked the mine for 20 years, and the people of the district have to submit to the monopoly of a company which charges £3 per ton for all goods without distinction carried over their line. What would the West Coast people say if they were treated in a similar manner?

But, to come back to my subject, I must say that, although tin-raising was started in the latter part of 1872, with the hope of an early dividend, it took over five years before the Bischoff Company found itself in this pleasant position. People were in those days, as they are at the present time, too sanguine in their calculations, not allowing for unforeseen troubles and other contingencies,—their under-estimating the capital and the time required to do the work. This refers particularly to Tasmania, as few other colonies, perhaps New Zealand excepted, can show so many difficulties in the mining districts as Tasmania.

Mr. Crosby's health failed, and he resigned in the middle of 1875. I succeeded him, and took charge on the 16th November of the same year, and, although a large amount of work had been done, dividends were as far off as ever. It appears that in the anxiety to bring the mine into the state to pay dividends everything was overlooked, particularly the system to carry on the work. Good ground, the best known

at the time, was being worked regardless of expense; the consequence was, very little profit could be made.

At the ore-dressing sheds things were no better than they were at the mine; and although the ore-dresser, considered a good man, had a scheme by which he worked, it was a very poor and expensive one. The hand-jigger and all the old primitive appliances his great grandfather used to work with were here collected, which necessitated a renewal of the whole plant at the earliest possible date.

At this time my principal attention was directed upon the mine in laying down a system for working it, and, although I had all the monetary help I required, it took me till February, 1878, to declare the first dividend (£12,000) of £1 per share; by this time the bank overdraft stood over £40,000.

This dividend might have been declared earlier had it not been for the bad state of the road between Bischoff and Emu Bay, as by the end of the year 1877 we had over 1585 tons of ore at the works, which had to be first carted, during January, February, and March, and smelted before the money was available. But, besides this, another unforeseen circumstance happened at this particular time by which the company's profits were considerably reduced. At the time our carting season opened metallic tin stood at £72, but before many tons reached London the price fell gradually until it got down to £56 and £55, at which price the company had to sell a large quantity. This was a great loss, but, under the circumstances, it could not be helped, as the shareholders had waited long enough for their first dividend. It may be that the bank was the only one regretting losing such a good customer.

Up to this time criticism was in full swing, both by shareholders and the outside public, trying to prove me incompetent and make me responsible for other people's sins. The shareholders began to show signs of becoming impatient about the long-deferred dividend. It is easier to find fault than to improve matters, and anyone at the scene of action could see that no time was lost and the work to be accomplished was no easy task.

With the exception of the places selected by my predecessor for working, the whole ground was nothing but thick forest and horizontal scrub, and the timber was not easily cleared during the wet season, which lasted nearly nine months at a stretch. For the clearing I selected the first

summer, and this turned out exceptionally favourable for this kind of work. We started at the bottom of the hill, where I intended to commence operations, and cleared several acres of ground, which lasted for several years. But from the day we started the winter work (sluicing) the trouble began, as we had, against expectation, to work about 3 or 4 chains of very poor ground, the washdirt being very shallow and poor in quality; in fact, it hardly paid working expenses. This continued until we reached a point where the bottom began to run level, and from there the dirt became deeper, and improved in quality each foot as we advanced.

In the Slaughter-yard Gully (a slight impression in the hillside higher up), the dirt was very good, but there was no quantity. The Brown Face I had also started; but as soon as the surface dirt was removed it became very stony, and it was apparent that something had to be done to keep the eight sluices going which I had then working. To overcome this difficulty I decided to start a drive into the hill, sink a shaft to connect with the drive to act as a pass, and supply the sluices with the surface dirt (if that should be found necessary), which appeared very good on the top of the hill. The drive was to act in a double capacity—first, to procure dirt, and then to prospect the interior of the formation, as my hopes of this iron-capped formation were very great, and I had the fortune to see all my hopes fully realised. As soon as we got through the stony or gossan formation, which appeared here in the form of huge boulders, we broke into a decomposed porphyry highly charged with tin ore (Cassiterite). This change came very suddenly, and before I thought I could reasonably expect it; but, nevertheless, it was equally welcome, and from that time a great portion of my troubles ended, or at least got greatly mitigated, as my opponents, who continuously criticised and condemned my works felt themselves beaten, but still doubted the correctness of my reports.

Great improvements set in in the different working faces, which affected the monthly output satisfactorily; but the ore-dressing appliances remained in their old state for some time to come. As a starting-point I erected an old second-hand 5-head battery sent up from the coast, so as to be able to reduce some of the better ore picked out in the sluicing process. This battery was started in December, 1876, and for that month I produced 187 tons, this being the first time we reached such a high return, and it was very satisfactory

to increase the output in very little more than 12 months from 45 tons to the above. Up to this time it was all uphill work, as the improvements in the different faces were very slow, and the hopes of the Brown Face had not been realised then; but this event was close at hand, with the result that the output of the mine reached 250 tons for the first time in August, 1877; and I may confidently say, never in the history of tin mining has this quantity been produced per month with such limited appliances as we had at our command at that time. Shortly after that I started new dressing-sheds, still keeping the old ones at work.

At the mine everything went on well; the number of sluices had been increased from 4 to 30, and afterwards to 32; reservoirs built for water storage purposes, &c.; and, although we had at that period to all appearances an enormous supply of washdirt, I knew that it could not last for ever, and therefore it was necessary to provide ways and means for any change of this kind, so, with the consent of my directors, I erected additional crushing power, in the form of a 15-head battery, on the upper floor, which was completed and started to work on the 10th September, 1879. Later on this was supplemented by a 40-head battery at the bottom of the Waratah Falls, and just below the former sheds. The preparatory works in connection with what is now called the 60-head battery was by no means a small job. The ground had to be cleared and excavated, and then it was necessary to face the whole of the cutting or parts excavated with a substantial wall set in cement, so as to form a support for the upper sheds and the precipitous basalt cliff running all along the river, which is in reality only a floating rock resting upon clay. The foundation of this wall is in places six feet and over in thickness.

The whole of this additional machinery was not finished too soon, as before I could start the 40-head battery some difficulty was experienced to keep up our fixed output. But this was not all, for with additional crushing power we required also additional water power, and by this time we had already found that the River Waratah was not large and constant enough to supply all the power required, and it became therefore necessary to look round from where to secure the additional supply required. I consulted with my directors about ways and means, and, after a lengthy consultation about steam *v.* water and an examination of the surrounding country, it was at last decided to give my pet

scheme (Falls Creek) a trial. Prior to this we had examined the Wandle, the Fossey, and the Cold Stream, and had taken levels, but all confirmed the impracticability of connecting any of these with Waratah, as the least difficult one would have required a tunnel of at least four miles in hard basaltic rock, an undertaking which might have taken many years to accomplish, and a very expensive one too.

When the first embankment across Falls Creek, which was only 12 feet high, was finished at the beginning of the summer 1881, and when the races and flumes to convey the water to the works were also finished, we were able to keep the machinery partly employed, and although the dam was not quite full, still, by crushing fairly good stone, three dividends, each £6000, was the reward for this experiment. With this result I need not say that reservoir-building became the order of the day, and now it is finished we have six reservoirs, covering about seven miles of water, along the line of the creek when all are full. In addition to this, we have added since the Fossey scheme, by which water is brought from the foot of Mount Pearce, a distance, including race and flumes, of 4 miles 32 chains. The water conveyed by this scheme helps in certain seasons a good deal to keep up the supply, but, unfortunately, in the height of summer, when it is most required, we cannot depend very much upon it, as we had to tap the stream rather near its source.

Our crushing power consists of a total of 75 stampers, with assistant works (slime-sheds) for re-working the refuse. These were considered necessary on account of the nature of the ore, which principally consisted, in the early period of the mine's history, of gossan from the Brown Face, which has a tendency of thickening the water, on account of the large percentage of iron it contains, and thereby causing part of the fine ore to float away, also fine particles of ore adhering to the sand may also be carried away; all of which is collected in these sheds as far as possible. Besides these works at Waratah, other subsidiary works are erected a mile lower down the river, where it junctions with the tailing gully from the Mount. Here all the dirty water from the mine, and such tailings that escape, are collected and worked over again. All these works are very profitable, and reduce the loss to a minimum, as the results of the tailings' works lower down the river belonging to other companies go to prove.

In the early days, when the works at the mine were carried on on a small scale, a wooden horse-tram, worked in

conjunction with the other companies, was sufficient for all requirements; but as the works at Waratah expanded a separate iron tram, still worked with horses, was constructed. Even this, on account of the high working expenses, and the insufficient quantity of material which could be carried over it daily, had to be replaced soon afterwards by a proper railway line worked by locomotive, which has up to the present worked cheaply and satisfactorily.

The crushing and ore-dressing expenses are very low, only amounting to a fraction over 1*s.* per ton, and those of the assistant works are equally low in proportion. The total cost of production is about £16 per ton of ore.

One of the principal questions, that of water conserving, had my early attention, and, in addition to the Waratah supply, a good deal of similar work has been done at the mine. Three reservoirs are built there,—two are situated about the working level of the Brown Face, while the other one is at the top of that face. With these three reservoirs we can command the whole workings. In the early days, when the climate was even more favourable (*i.e.*, wet) than it is at present, the water supply was not sufficient to supply all the sluices with clear water, and the important question arose as to the best way of working so as to economise the water to the greatest benefit of the Company. The question was, would it be better, for the sake of saving all the fine ore, to supply all the sluices with clean water, and only work—perhaps not half-time, or better to use the water over and over again until it reached the bottom of the workings, and by that time had become unfit for further use, and then to re-work the refuse for what fine ore had escaped? After due consideration it was decided in favour of the latter scheme, and from that time up to the present this plan has been steadily followed.

Before the Bischoff Company acquired the ground belonging to the Waratah T. M. Company, a little shed was erected near the boundary line of the last-mentioned company's section for the re-working of the tailings coming from the mine, which paid very well; but as only a part of the tailings coming down the gully could be treated, I managed to intercept part of them in cheap and roughly-constructed dams below the shed for further use. This opportunity came when the Waratah Company offered its mine for sale. This section extends right down the tailings' gully to where it junctions with the Waratah River, and, seeing the advantage of the

situation, I recommended my directors to purchase the same. This led to the erection of the Ring-tail Sheds, where, ever since, the tailings of the mine have been re-worked. Here we have greater facilities to do the work on a larger scale, and I took care to have the sheds large enough for all possible requirements. The result has been very good, as, up to the end of November, 1891, we have produced no less than 1116 tons of good ore from these sheds.

Later on I erected another shed, the "Catch'em," lower down the river, which enables us to re-work all the tailings coming down the river. This shed also pays very well, as all the concentrates contain a large percentage of specimen-sand, which is further reduced in a Chilian mill and then treated for "slime." Some of these slimes are very fine indeed, and require special care to finish off.

At Waratah, as well as at the mine, the same care has been taken to make the best use of the water, and full advantage has been taken of the natural facilities offered at the machine site. For this purpose the sheds, with the water-wheels, have been so placed that the water from the top one is available for the next one on the floor below, and so on. In all seven wheels work almost with the same body of water, and produce in round figures about 200 h.p., thus securing the greatest amount of motive power with the least possible waste, besides the water required for ore-dressing purposes. To effect all this, a scheme had to be arranged from the beginning of the works and carried on gradually as the works expanded, and, I am pleased to say, that I have stuck to the primitive waterwheel, as it is so easily managed by unskilled labour. The result is more satisfactory than if I had selected either the turbine or the Pelton wheel, both motors well liked, and giving great satisfaction in places where water is abundant and is obtainable under high pressure. The completion of these works were only effected about three years ago ; this includes the electric light and telephone system throughout the works.

There is little left to close this brief description of the historical part of the mine, so far as I am able to relate it. Certain occurrences and incidents I had to leave out, as I do not like to become personal, and on that account I have to ask your indulgence should my description appear not quite correct to anyone who has been observant and interested in Mount Bischoff in the earlier days.

To close my record I must not omit to give a few figures to

show the producing power of this Company. At the 30th June last the ore produced amounted to nearly 37,088 tons, to the value of £2,300,000, out of which dividends were declared to the amount of £1,138,500, besides the dividend tax of over £46,000. The money expended before the first dividend could be declared amounted to the nice round sum of £100,000.

Geology of Mount Bischoff.

The geological formation of Mount Bischoff consists principally of old slate and sandstone—as far as yet proved, non-fossiliferous—and is intersected by numerous dykes of "eurite" or "quartz-porphyry" and "topaz-porphyry," which latter rock we may consider almost wholly accountable for the ore formation. The intrusion of these dykes has produced some alteration in the above sedimentary rocks by converting them into a rock resembling hard chert. The dykes strike from the Mount (2650 feet above sea-level) in all directions, except northward, which is, so far, not proved as yet; but I have no doubt they will also be discovered in that direction should the ground be cleared of the surface soil. One of the principal ones is that connected with the Brown Face, which forms a crescent of considerable sweep and length; others crop up only here and there, and show, therefore, interrupted lines. All these dykes within a certain zone are more or less stanniferous, and must have played an important part in the drift formation of the district. On this account we may class the tin ore occurring at the Mount in two distinct parts—the stanniferous drift and the lode tinstone formation.

The former was principally worked in the early days of the Bischoff mine; in fact, for more than seven years nothing but washdirt was worked, and only when by calculation it was found that the supply could not last above a certain time attention was directed to the latter. One peculiar feature in the drift formation is that it started at the foot of the southern slope, extending both east and west, in a very thin layer, and resting on the bottom, showing an angle of from 40° to 45° rise, and this continued so for at least a couple of hundred feet; and it only increased in thickness when the bottom began to take a flatter inclination. Its greatest thickness on the southern slope was over 70 feet, good tin-bearing dirt from top to bottom. The remarkable part of this formation is that it does not rest on a true bottom, but on

what I consider is an older wash, which, when properly prospected, may lead to some valuable discoveries.

The wash just mentioned was found accidentally when sinking a prospecting shaft at the foot of the hill to fix a point where to start work for tin ore, and also to ascertain whether the stanniferous wash extended further down the slope. This shaft was sunk to a depth of about 35 feet, when the influx of water interfered with further progress. It was never expected to reach that depth, and without timber it became unsafe for the workmen, and had to be abandoned. The sinkstuff consisted of well-rounded boulders of carbonate of iron (siderite), iron and magnetic pyrites (pyrite and pyrrholite), zincblende (sphaterite), and other minerals of a similar class. At that time I could not connect this formation with anything known in the locality ; but since I have driven the main tunnel through the hill I have come across a serpentine formation containing similar minerals, with the addition of variously-coloured steatite, which I never observed in the wash, but it is not unlikely that this mineral, on account of its extraordinary softness, was ground up, and formed the clayey substance between the boulders. Up to the present moment I cannot find any other formation which may have supplied the material of that deposit. This same deposit extends over a considerable distance along the southern slope of the hill, as proved by two adits, but is not connected with the stanniferous wash in any place. The two drift formations are separated by a layer of micaceous clay, resting again upon pyrites, in places of considerable thickness ; but, as pyritous minerals of any kind are objectionable to mix with tin ore, nothing has been done to explore it. Some thin galena veins have been discovered further west, where solid ground appears to set in, the galena assaying as high as 100 ozs. of silver, with a good percentage of lead, per ton. Higher up the hill the true bottom (slate) rises up in an abrupt wall standing from 50 feet to 70 feet in height, with a slight S.S.E. underlay and a strike N. 65° W., which reduced the wash considerably, and the latter ran out eventually towards the Stanhope Company's southern boundary line. In this particular locality topaz-rock with tin ore was first discovered in the washdirt by Professor Ulrich, at present in the Dunedin University, N.Z., but then in the Geological Department in Victoria. Later on I sent by a friend of mine a small collection from the mine to the Mining Academies of Clausthal (Hartz Mountains) and

Freiberg (Saxony). The late Professor Dr. v. Groddeck wrote a very interesting paper on the topaz discovery, which he valued very highly, copy of which was also laid before the Royal Society of Tasmania, and, I believe, excited great interest. This paper gave rise to a scientific dispute between Dr. Schröder and Professor v. Groddeck about the locality from whence this specimen came, and the former maintained that it had come from the "Schneckenstein," in Saxony, and was by mistake ascribed to Tasmania. These two formations must therefore bear a close resemblance to one another, and future exploration in our locality will be a matter of great interest.

At the present we have already done something in this direction. In the porphyry dyke, on the same line where the topaz rock was found in the early days, in the alluvial drift already referred to, striking nearly N. and S., similar stone has been found *in situ* of considerable value; but, not only does the topaz rock with tin ore occur there, pure and simple, but the porphyry also contains small crystals of the same mineral, and I have no doubt the same will apply to nearly all the porphyry dykes in the district. One remarkable feature presents itself, and that is, none of these dykes keep stanniferous after passing a certain line, beyond which the porphyry changes its whole character, both in hardness and its outside appearance. On the North Valley Road, not half a mile from the centre of the tin-ore formation, all the porphyry dykes are barren, and look quite different, and at first sight no one would think they were the continuation of the dykes crossing the stanniferous formation. One of these dykes shows large cubical crystals of iron pyrites, and is besides very dense and hard; other dykes have other peculiarities, but they are all barren outside the stanniferous zone.

Returning to the peculiar formation of the drift, we have to distinguish the diluvial from the alluvial, *i.e.*, the older waterworn (rounded) wash from the newer, which shows sharp edges, or nearly so. Whether this difference is to be accounted for by age alone, or whether the water action has been more active in one place than in the other, is not very easy to decide; but I do not think there can be any doubt that the Mount has presented different configurations during its existence.

How could it be possible, for instance, to deposit any material upon an incline of 40° and more without precipi-

tating part of the material lower down the slope, and form a deposit of a similar thickness all over the lower-lying ground? but as this is not the case, it is only reasonable to accept that the country, or better, the locality, in days gone by presented a different appearance from what we see at present. Besides, it is next to certain that these porphyry dykes were at one time of far greater height, and only through atmospheric action have they been disintegrated, and formed this enormous deposit of porphyry-wash from top to bottom of the workings, of over 70 feet in thickness in one place, as previously stated. A slaty admixture in this wash is only noticeable on the north-western rising ground, extending right up to the summit of the Mount; but the deposit here gets thinner as it gets nearer the top of the Mount, still maintaining its stanniferous character.

The other formation—the Brown Face—is unique in itself. A large ferruginous gossan formation rises about 108 feet above the floor of the crescent already alluded to, and is hemmed in on both sides, *i.e.*, east and west, by porphyry wash of a certain depth. At the depth of 30 feet below the floor prospecting works have been carried on, and have proved that the formation at this depth is resting upon the slate on the north side, but is cased in on the other sides, at the points of intersection of the drives, by a thick coating of iron pyrites and black clay, the latter separating the former from the gossan formation of the Brown Face. It is only reasonable to suppose that this formation, *i.e.*, the black clay, continues to a greater depth, and must act as a protecting mantle of the other.

Different theories have been formulated to explain the origin of the Brown Face, but up to the present the problem is unsolved. By all appearances it is not a lode; but whether it is a "stockwerk" or a "geyser deposit," as some assert, I will not venture to say at present; the last idea seems to me, however, quite out of the question. I am rather of opinion that it was originally a huge iron pyrites formation, impregnated with tin ore, the same as represented in the North Valley Lode, and that, through the action of air and water, and other agencies of nature's laboratory at present not noticeable, the enormous change in the mineral character and outward appearance has been brought about. This opinion is strengthened by the acidic or iron vitriol character which it still retains, and also by the large amount of ironstone (brown hematite or limonite) found on the northern boundary

of the formation. It may also be mentioned that all the water draining from the side of the Mount where the workings are situated are rich in sulphate of iron and deposit iron ochre.

So far as is known at present, the formation is an inverted cone-shaped mass, getting smaller as it descends, and, at the depth of 260 feet below the crown of the hill, in the main tunnel, it break up into thin ore-veins containing ferruginous tin ore, with iron pyrites intermixed. Down to this point the ore is clean and free from pyrites or any other objectionable material. At one time I decided to sink a blind shaft in the main unnel to ascertain the character of these veins and their value at a greater depth, but since the Mount Bischoff Company has acquired the North Bischoff Valley property, I have considered it cheaper and more to the point to explore from that level, which is about 700 feet below the Brown Face working level, and for which work an efficient plant is in course of erection. This course is also more advisable, because the North Valley Lode strikes in the direction of the Mount, and may be found connected, if not with the Brown Face itself, with some of the other workings.

But, besides the Brown Face deposit, there is another one of not less value, namely, that of the Slaughter-yard Face, which is of great extent. This is worked in different places, and its full length at present known is about 15 chains, and its width several hundred feet. Its strike is about N. 25 E., and it presents a similar character to that of the Brown Face, only that it carries iron pyrites at a shallower depth and is more silicious in places. Its value as an ore-producer is at present unlimited, as it must be fully 200 feet high from the lowest to the uppermost face.

In addition to the Mount Bischoff workings proper, there are the West Bischoff and the North Valley Lodes. Both have been productive in the early days when only clean ore occurred, but, as depth increased, the admixture of iron and arsenical pyrites somewhat interfered with the success of these companies, as pyritous tin ore requires different treatment, and the companies had not the necessary appliances. Still it does not follow that if once pyritous ore is encountered it must continue either in depth or lateral extent, for it has been proved at different times that clean ore came in in patches or shoots below the pyritous ore. This has, for instance, been the case in the West Bischoff Company's workings, where, besides on former occasions, quite recently

clean ore, in places over two feet wide, was discovered in the prospecting drive fully 350 feet below the surface. This, up to the present, has not been the case in the North Valley Mine, perhaps on account of its quickly-increasing greater depth below the surface, as every foot in advance into the hill increases this depth rapidly. Still, since the Mount Bischoff Company has acquired this property some very good pyritous ore has been taken out. Both the North Valley and the West Bischoff lodes traverse, in slate, with clean walls, when productive, but in non-productive parts the lodestone is intermixed with the hanging-wall or foot-wall, or both.

From this description it will be seen that so far we have, in the original Bischoff workings, not been successful with deep mining, which was rather neglected on account of the large deposit so near the surface. The deepest work is the main tunnel, which passes through the hill about 260 feet below the crown of the Brown Face, crossing in its course the different porphyry dykes, which carry tin ore in small quantities, associated with tourmaline, and, in places, iron pyrites.

The western cross-cut, bearing for the summit of the Mount, is all in altered (silicious) slate and sandstone, and crosses several thin quartz veins, of which two contain native copper and the others a little tin ore; on account of the hardness of the ground they are of no particular value. We passed through the porphyry dyke of the summit of the Mount several hundred feet further west than its outcrop, which proves either that it has a strong westerly underlay or that there did exist a disturbance in the ground. This dyke was found very hard and barren.

There is another question which may be of some interest and deserves mentioning, and that is the probability of deep leads existing in the neighbourhood under the basalt, as is the case in Victoria and other places with gold, and in New South Wales and Queensland with tin ore. In three directions from the Mount there is evidence that stanniferous drifts exist below the Mount Bischoff workings—northward in the North Valley, southward in the old Don Company's property, and south-westward Tin Creek. In Tin Creek tin ore was first found by the discoverer of the Bischoff mine, and ultimately led to the discovery on the Mount itself. Nothing of value, however, could be afterwards found in Tin Creek, as the ore was confined to a thin layer of wash occurring next to the bottom, and the ground taken up was soon abandoned.

In the old Don Company's ground the deposit is of a different character. Beneath the surface soil we find tin drift varying in thickness; below that occurs a black or grey clay (in places fireclay), through which a large quantity of leaf impressions and lignite is distributed, just like real lead material, and below that occurs another layer of heavy wash. An attempt was made to prospect this formation, and a shaft was sunk to a depth of about 100 feet before the bottom was reached. The work was very heavy—boulders tons in weight having to be broken and sent up the shaft—and the washdirt found amongst the boulders, although fairly good in places, was not sufficient to pay for the work. As the company was, besides, not a strong one, the undertaking had to be abandoned before any definite information was gained. All we know, so far, is that the bottom rises rapidly northward and is very uneven. This deposit may be the commencement of a deep lead.

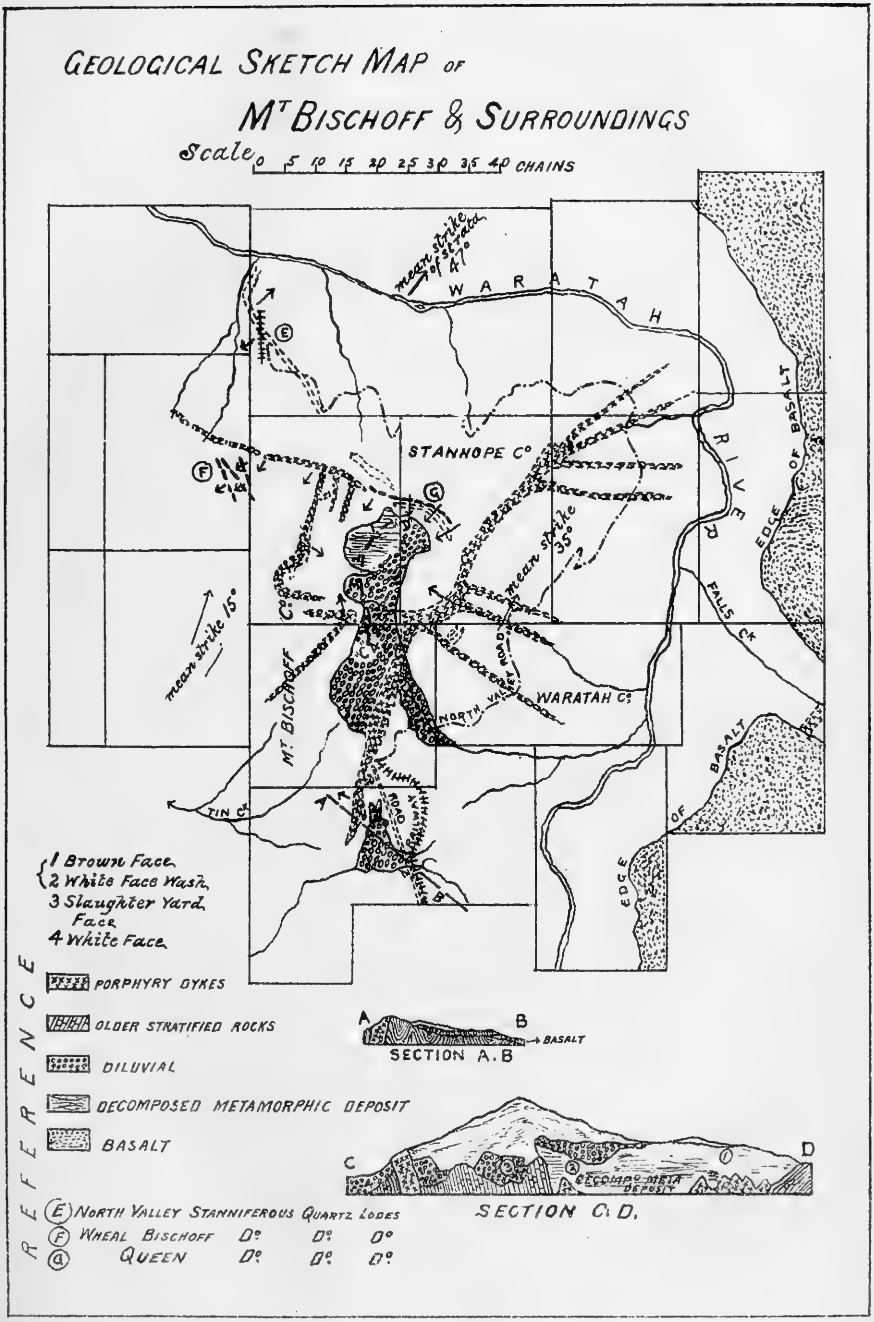
Although the prospects appeared not very encouraging, still, to set the question about the existence of a deep lead at rest, a prospecting company was formed, and, with the help of the Government diamond drill, a series of bores were put down about three-quarters of a mile south-west of the Don Company's ground, with the result that deep ground was discovered, but without any trace of tin ore, or even of the tin porphyry. There the matter rests at present, but it remains still a moot question whether the lead, if one exists at all, does not take a different course to that supposed by those interested in the company just alluded to, and as indicated by the borer.

In conclusion, I must state that in the foregoing paper I have endeavoured to bring under the notice of the Members all the leading features of the mine and its surroundings. I am conscious of the imperfection with which I have carried out my task, and hope that some more capable geologist than myself will at no distant date make the geology and mineralogy of the Mount his special study.

A geological map of Mount Bischoff, compiled about twelve months ago, accompanies this paper, and may help to explain the foregoing.

8.—ON THE AGE OF MAMMALIFEROUS DEPOSITS IN AUSTRALIA.

By Professor TATE, F.G.S.


GEOLOGICAL SKETCH MAP OF
M^T BISCHOFF & SURROUNDINGS
Scale 0 5 10 15 20 25 30 35 40 CHAINS
mean strike of strata 47°
WARATAH
RIVER
STANHOPE C°
mean strike 35°
mean strike 15°
MT BISCHOFF
WARATAH C°
NORTH VALLEY ROAD
FALLS C^k
EDGE OF BASALT
TIN C^k
ROAD
RAILWAY
1 Brown Face
2 White Face Wash
3 Slaughter Yard Face
4 White Face
REFERENCE
PORPHYRY DYKES
OLDER STRATIFIED ROCKS
DILUVIAL
DECOMPOSED METAMORPHIC DEPOSIT
BASALT
SECTION A.B
BASALT
SECTION C.D.
DECOMP^D META DEPOSIT
(E) NORTH VALLEY STANNIFEROUS QUARTZ LODES
(F) WHEAL BISCHOFF D° D° D°
(G) QUEEN D° D° D°

9.—REMARKS ON THE THEORY OF CORAL REEFS.

By W. J. CLUNIES ROSS, B.Sc. Lond., F.G.S.

[*Abstract.*]

AMONG the results of Mr. Charles Darwin's observations made during the voyage of the *Beagle* in 1835 and 1836, was his well-known theory of coral reefs, by which he sought to account for the origin of the three classes of fringing reefs, barrier reefs, and atolls. This theory was very generally accepted for a long time, but during recent years has been questioned by several writers. Shortly after the account of the *Beagle's* voyage was published, however, the theory was disputed by a man who had had exceptional opportunities of studying the phenomena of coral reefs; and as his "remarks" have never been published, and have as much force now as they had 50 years ago, an abstract of them is given, together with some other suggestions.

The man to whom allusion has been made was Captain J. C. Ross, who colonised the Keeling or Cocos Islands, in the Indian Ocean, in 1826. The Cocos were visited by Darwin in 1836, and while there he thought he obtained proofs in support of his theory that atolls always indicate an area where the sea bottom has been sinking. One of these was the finding of posts standing in the water. These, he states, had formerly been the posts of a house which had been abandoned owing to the sinking of the land. The posts had really never been part of a house, but had been placed in the water between tide-marks for a particular purpose. The structure of the islands also shows that there had been elevation rather than subsidence, since masses of coral, evidently in the places where they had grown, are found at a height of 20 feet above high water-mark, and, since the Cocos form a true atoll, this is distinctly opposed to the Darwinian theory. It is further pointed out that the growth of coral, which goes on below low water-mark, would not preserve the islands with their covering of cocoanut trees from submergence, since that would require additions to the top of the islands and not to their sides.

A consideration of the supposed areas of elevation and subsidence which Darwin thought he could recognise in the Pacific and Indian oceans shows that they by no means support his theory. In the areas of subsidence, which he says are characterised by atolls and barrier reefs only, there

are many elevated islands, such as Aurora Island, in the Low Archipelago, 250 feet high. Java, Sumatra, and the neighbouring islands were supposed to be situated in a rising area, but it can be shown that there are many atoll reefs in the neighbourhood.

These and other considerations lead one seriously to question the Darwinian theory as a sufficient explanation of all the phenomena of coral reefs, and in fact the theory appears to have been largely accepted because there was no other satisfactory theory proposed. Darwin objected to the view that coral reefs might often be founded on submarine volcanic cones, on the ground that it was not likely so many mountains would come close to the surface without rising above it. In reference to this, it may be pointed out that if a volcano builds up a cone to the surface the upper part is usually of loose materials, and will generally be washed away and the cone remain as a shoal. Graham Island in the Mediterranean, and Sabrina in the Azores, are cases in point. Such a shoal would appear to be a suitable foundation for coral reefs, and recent investigations of the geology of Tonga have proved that there reefs had been founded on submarine volcanic mountains which have since been elevated.

10.—SOME ALLEGED INDICATIONS OF CATASTROPHE: AN ENQUIRY.

By REV. J. C. CORLETTE, D.D.

[*Abstract.*]

THIS is an appeal for further light connected with the revival of the question of Uniformity *versus* Catastrophe raised by the recent work of Mr. Howorth, "The Mammoth and the Flood." Here the theory of perpetual, absolute uniformity of degree in the operation of those causes which have given the earth its present form, is assailed from the side of palæontology. A copious array of facts is given, from which the occurrence of some such diluvial catastrophe as that described in the Bible and represented so widely in human traditions is inferred.

Professor Huxley's observation in his address to the Geological Society in 1869 is quoted as encouraging further consideration of such facts. He rejects any theoretical antagonism between Catastrophism and Uniformitarianism ;

on the contrary, he says, it is very conceivable that catastrophes may be part and parcel of uniformity. He takes the striking of a clock as an illustration of catastrophe, whilst its time-keeping illustrates uniformity of action. Here we see catastrophe itself governed by law. A narrow view of the universe does indeed either exclude catastrophe, or sees nothing else. The true broad survey which Christian revelation affords puts catastrophe in its proper place as but one item in the great system of order which pervades the whole.

The foremost of the facts alleged by Mr. Howorth is the enormous extent and quantity of mammoth remains in Siberia. Over a vast area where animal life can now be scarcely, if at all, sustained, the remains of hordes of *Elephas primigenius*, accompanied by rhinoceros, have been discovered for many years past, sufficient to maintain a considerable trade in ivory. In what is now an icy wilderness, the bones of these, with other large animals, are found in quantities that represent enormous herds.

The extraordinary quantity and variety of animal remains in general that have been found in pleistocene deposits, the strange mingling of predaceous and non-predaceous species, of old and young, large and small, is required to be accounted for, in contrast with current observation of bone deposits now in progress. Important authorities are quoted calling attention to the great disparity in quantity between animal remains occurring in pleistocene beds and those which are now accumulating. North and South America afford examples of this. Of the huge animals found embedded in the Pampan mud, Charles Darwin said, "The number of bones embedded in the grand estuary deposit of the Pampas must be very great. . . . We may conclude that the whole area of the Pampas is one wide sepulchre for these extinct animals." "*Ossium maximorum farrago*" is the expressive description given by a German naturalist of deposits he had seen in Asia. It is urged that the discovery of masses of animal remains of mixed species, all showing the same state of preservation, not only points to a more or less contemporary death, but is fatal to the theory that they died from purely normal causes.

The condition also of the bones thus found, with thin fine edges and delicate angles and muscular attachments preserved intact, often lying together as when articulated, and though extended over the area of a whole continent, yet, for the most part, in the same mineral condition and state of

decay, leads us to conclude that the animals died together, and together were protected from decay. As for the mammoth, there are credibly attested cases in which it has been discovered embedded in frozen earth, with flesh, and skin, and hair. It is admitted by eminent geologists that the condition of many mammoth remains in Siberia indicates conclusively that the animals were enveloped in ice or frozen mud suddenly, and that the ice in which they perished has never melted from the moment of their destruction. Professor Brandt, of Berlin, was able to pronounce as to the condition of the head of a rhinoceros, that there were evidences pointing towards death by asphyxia. The bodies of certain mammoths were discovered standing upright in the enveloping ice shroud, facing towards the north.

The character of the localities in which these enormous osseous deposits are found in Siberia is not that of river-beds only, ancient or present, nor low-lying marshes, nor land that could ever have been boggy. "Experience has shown," says Wrangell, "that more are found in elevations situated near high hills than along the low coast, or the flat tundra." Vast hecatombs are discovered 150 miles away from any considerable river, or in high grounds far away from any possible river channel.

The conclusion suggested is that the mammoth and its companions perished by some wide-spread catastrophe which operated suddenly over a wide area, not by the slow processes of the ordinary struggle for existence, not by accumulation under normal causes, but by one of Nature's hecatombs, when a vast fauna perished simultaneously.

The quantity, nature, and condition of bone deposits in many large caves and fissures are claimed as pointing to a similar conclusion. Setting aside caves that were at some time wholly or partly lairs of wild beasts, or habitations of men, there are many of great size crammed full of bone *débris* representing all sorts of animals, man included, filled up to the roof, with perhaps a layer of stalagmite on top, the interstices between the bones made up of gravel, clay, shells, and other detritus, the identity of which, with the diluvium around, has been accepted by many scientific observers.

Mr. Howorth sums up his conclusion thus: "The destruction of a fauna, great and small, old and young, the piling of a mixed medley of its remains upon one another in a state of freshness without signs of weathering or decay, is, in the case of caverns, as in that of surface beds, only consistent

with some wide-spread flood. Such a flood would scour the country and mix gravel and bones together; would force the bones, &c. into the inner recesses of the caverns, and drive the fæces, as Falconer found them driven, into the roofs of the caves; would rush through the valleys and enter any holes there were in their sides; would drown great beasts, and would as easily carry their carcases along; would sweep up land-shells and fish as well as mammals, and pile all together in heterogeneous masses."

The Duke of Argyle, in his address to the Edinburgh Geological Society in 1883," after referring to facts such as have been mentioned, added—"Nothing, I think, but the bondage of a theory which is not founded on any sound philosophy could banish from our consideration the high probability of one single explanation, which is this,—that in very recent times great changes in the moulding of the earth's surface over a great part of Europe occurred with sufficient rapidity to cause a great destruction of animal life, and, during the progress of a wide submergence, to sweep the bodies of the drowned creatures into fissures and swallow-holes which were opened or enlarged at the time."

One of the most interesting features of the facts alleged in this connection is the recognition by competent observers of a complete break, a hiatus between the human remains found among the extinct fauna referred to, representing palæolithic man, and those of the later, but still ancient neolithic age. With pleistocene, palæolithic man a complete fauna disappeared. With neolithic man a new fauna appeared. Chief among the differences between the fauna of the two periods is the large introduction of domestic animals in the later period. The complete and sharply-defined disappearance of one type of man with a distinct fauna and flora, and their replacement by a new type of man with a new and distinct fauna and flora, is said to argue the complete destruction of the one and an entirely separate and distinct new beginning through the occupation of the old district by a fresh migration.

The facts put forth in the argument referred to are very numerous, and are gathered from all parts of the world, though nowhere, perhaps, so frequent and pronounced as in the case of the Siberian mammoth. They point to the operation of one common cau e of a cataclysmic character, involving some great cosmic change probably, that must as to Siberia account for an instantaneous change from a tem-

perate climate and a thick-growing forest, the feeding-ground of hordes of these monsters, to a frozen wilderness of mud, in the depths of which their sudden destruction and congelation is now revealed to us. This catastrophe, though universal in a general sense from the wide extent of its chief phenomena, the depression and submergence of large tracts of continent all over the world, with the elevation of some mountain chains (possibly, it is suggested, of the Andes in South America), yet is not claimed to have been so absolutely universal as to preclude the preservation of large insular areas, upon which many animals could escape the general ruin.

The enquiry now proposed with all respect and sincerity in this connection is—What further word may natural science have to say as to the nature of the facts alleged, or as to the conclusions drawn from them? What new arguments or new facts may specialists have to offer the general public with regard to the phenomena referred to? May any hope be indulged that another link may ultimately be established here between the conclusions of natural science and the simple outlines of pre-historic phenomena which are given us in that ever more and more wonderful book, the Bible? Have we in these alleged indications of catastrophe any warrant for a conclusion upon any basis that science will accept that the world has known catastrophe, monstrous and universal, since man's appearance upon it? At the same time, we should all be prepared to take it as an axiom that all catastrophe is subject to law, is a part of one law in which natural and spiritual coincide, namely, the moral government of the Almighty Creator of the universe.

11.—NOTES ON THE PERMO-CARBONIFEROUS ROCKS OF NEW SOUTH WALES.

By Professor DAVID, F.G.S.

Section D.

BIOLOGY.

President of the Section:
W. BALDWIN SPENCER, M.A., *Professor of Biology in the University of Melbourne.*

1.—ON THE ORIGIN OF THE STRUTHIOUS BIRDS OF AUSTRALASIA.

By F. W. HUTTON, F.R.S., *Professor of Biology in the University, Christchurch, New Zealand.*

The Struthious birds, or *Ratitæ*, are confined to the Southern Hemisphere, with the single exception of the ostrich, which ranges through North Africa into Arabia, and formerly into Central Asia. They exhibit, however, greater variety of form in Australasia than elsewhere, and a few hundred years ago, before the moas were exterminated, this difference was still more marked. Mr. A. R. Wallace's explanation of this remarkable distribution is that the group originated in the Northern Hemisphere in the Cretaceous period, migrated southwards, and became extinct in the Northern Hemisphere. ("Geographical Distribution of Animals," vol. i., pp. 287 and 461, vol. ii., p. 370; "Island Life," p. 451.) This opinion is founded on palæontological evidence. In the Older Pliocene rocks of the sub-Himalaya the remains of an ostrich and of another genus—*Hypelornis*—supposed to be closely allied to the cassowary, have been found. No *Ratitæ* are known in the Miocene, but in the Lower Eocene of Europe and North America remains of *Gastornis*, *Dasornis*, *Remiornis*, and *Diatryma* occur, which are united—perhaps with some other forms—into a family called *Gastornithidæ*, generally supposed to represent the earliest Ratite birds. In the Middle Cretaceous period all the known birds were very different from living ones, and although flying birds and flightless birds existed even then, the flightless birds were adapted for swimming, while the *Ratitæ* are specially adapted for a terrestrial life. It is true that *Hesperornis* had a skull

somewhat on the present Ratite pattern, but that pattern appears to have been at the time common to all birds, and the typical skull of the true *Carinatæ* was not developed until later, probably not until the Middle Eocene. Previously, in the Upper Cretaceous and Lower Eocene, there were no true *Carinatæ.* Although many of the birds had keeled sterna, they all belonged to the *Proto-Carinatæ* of Professor T. J. Parker, of which the Tinamous and Opisthocomus of Central America are still living representatives. That the *Ratitæ* are descended from flying birds is now generally allowed, but the characters which are used to unite them all into one group are either early *Proto-carinatæ* characters or else are merely adaptations to terrestrial habits, and consequently of little value as evidence of affinity. It is therefore possible that the *Ratitæ* may have had more than one origin, although all have sprung from the *Proto-carinatæ*, as indeed have all living birds.

If the *Ratitæ* have a single origin, and if the *Gastornithidæ* belong to the *Ratitæ*, then no doubt the *Ratitæ* originated in the north and spread to the south, but if either of these statements is wrong the conclusion does not follow.

Now, by Mr. Wallace's hypothesis there are great difficulties in explaining how the Struthious birds reached Australia and New Zealand unaccompanied by placental mammals. We cannot suppose that they preceded the mammals, because so far as we know the placental mammalia are older than the *Ratitæ.* Neither can we suppose that they flew over a strait which was impassable to the mammals, because no bird that could fly could be admitted into the *Ratitæ*, the special characters of the group being due to their being unable to fly. The only alternative is that they swam across such a strait. But, although the emu is said to take readily to water, so also do many of the mammalia, and it is very unlikely that the Struthious birds should have twice swam across straits—once from the Oriental to the Australian region, and again from the Australian region to New Zealand—which were impassable to all the mammalia.

There are also other reasons for doubting the northern origin of the Australasian *Ratitæ.* The Struthious birds of New Zealand, including the lately extinct moas, make a nearer approach than do any of the other families to the original stock. This is shown by the lateral processes of the sternum, the free ischia and pubes, and the hind toe; and

further, in the moas, by the expanded sacrum and the less obtuse coraco-scapular angle in the smaller species.

Again, the only small *Ratitæ* are found in New Zealand, and if the group is descended from flying birds the smaller forms must have preceded the larger ones. We should expect to find the least altered forms near the place of origin, and if the New Zealand *Ratitæ* have migrated from Europe or Asia how comes it that all the least modified forms have been collected together in those islands? Flightless birds have generally been developed on lands where there are no carnivorous mammalia, and not on the large continents of the Northern Hemisphere.

There would be no great difficulty in accounting for a migration by land of these birds into Australia from New Zealand, while a counter migration of Australian mammals was prevented. At some former period, when New Zealand stretched towards Northern Australia, a portion of land, probably including Norfolk Island, and inhabited by *Ratitæ*, may have been detached from New Zealand and subsequently united to Australia, when the *Ratitæ* would spread into the mainland.

Mr. H. O. Forbes, in a paper read to the Philosophical Institute of Canterbury, N.Z., a summary of which was published in the daily press of the 22nd October last, has formed a new genus, called *Palæo-casuarius*, for the reception of three species founded on *tibiæ* presenting "many casuarine characters"; and if this determination is confirmed it will be a distinct proof that the cassowaries originated in New Zealand. It is, however, remarkable that so old a form as *Palæo-casuarius* must be should be still in existence in the Pleistocene period.

What, now, were the flying ancestors of the Australasian *Ratitæ?* The Tinamous of Central and South America resemble the New Zealand *Ratitæ* in several particulars, not only in the structure of the skull, but in the free ischia and pubes, in the presence of a free post-axial tarsal bone, and in the absence of tail feathers. As a former connection between New Zealand and South America is shown by the plants, the frogs, and the land shells, it seems more probable that the Struthious birds of Australasia originated in the neighbourhood of New Zealand from flying birds related to the Tinamous, and that they spread from thence into Australia and New Guinea, rather than that they should have migrated southwards from Asia. If this supposition is a

correct one, it follows that the passage of the birds from New Zealand to Australia must have taken place a very long time ago, certainly not later than the Eocene, because the differentiation which has since taken place is so great. According to Mr. De Vis, a femur belonging to one of the *Dinornithidæ* has been lately found on the Darling Downs, and if this turns out to be correct it will imply either that the *Dinornithidæ* were in existence in the Eocene, or that there was a second migration from New Zealand to Australia in the Pliocene period. Also, if *Hypelornis sivalensis* really belongs to the *Casuarinæ*, it will imply a migration into India from New Guinea; but the genus is only known by a single toe bone—the second phalanx of the third toe of the right foot. At any rate, if *Hypelornis* is a cassowary it must be a descendant, not an ancestor, of the more generalised moas.

If the Struthious birds of Australasia originated from flying birds in the South Pacific region, it is probable that the ostriches of Africa and South America have a different line of descent from that of the emus and cassowaries. The ostriches are distinguished by their soft downy feathers and the long plumes on the wing, and by the depressed and flattened bill. Also the extensor muscle of the leg has no "retus femoris," and there is no gall bladder. In all these points they differ from the Australasian *Ratitæ*, and while the ostrich and the rhea have two ungual phalanges in the wing and are polygamous, the emu, the cassowary, and the kiwi have only one ungual phalanx in the wing, and are monogamous. The ostriches may, therefore, have originated in the Northern Hemisphere—possibly as swimming birds—and the *Gastornithidæ*, which have relations with the *Anatidæ*, may be their ancestors.

The *Æpyornidæ* of Madagascar are related to the Raptatores, and they probably originated in Madagascar. If they are derived from northern non-flying ancestors, these ancestors must have passed into Madagascar from Africa during the Eocene period. They could not have come later, because none of the Miocene mammalia have found their way into Madagascar.

Note added, 11th January, 1892.—The facts mentioned in Professor Tate's paper on the Florulas of Lord Howe and Norfolk Islands seem to imply that they have been first connected with New Zealand and Polynesia, and afterwards

with Australia, as the Polynesian genera have undergone more alteration than those from Australia.

2.—NOTES ON SOME LAND PLANARIANS FROM TASMANIA AND SOUTH AUSTRALIA.

By ARTHUR DENDY, D.Sc., F.L.S., *Demonstrator and Assistant Lecturer in Biology in the University of Melbourne.*

1. Introductory Remarks.

The object of the present brief communication is not so much to describe species of land Planarians from Tasmania and South Australia, as to point out to local naturalists the desirability of investigating the Planarian fauna of these and other Australian colonies. A large number of land Planarians from New South Wales and Victoria have now been described and figured by various authors, but, strange to say, only a single species, the *Geoplana (Planaria) tasmaniana* of Darwin, has hitherto been recorded from Tasmania, and, so far as I am aware, not even a single one from South Australia. Nevertheless, there is no reason to doubt that these two colonies possess as rich and varied a Planarian fauna, in proportion to their extent, as either Victoria or New South Wales, and it is a matter of considerable importance that this fauna should be thoroughly investigated and compared with that of the neighbouring colonies, so that we may thus gain a valuable addition to our knowledge of the geographical distribution and variation of these interesting worms. I need hardly say that these remarks apply equally well to Western Australia and Queensland, from which colonies local naturalists might, I am certain, reap a rich harvest of land Planarians.

It is of especial importance that this subject should be attacked immediately, for Professor von Graff, the great German authority on Planarian worms, is engaged in preparing an extensive Monograph of the group, and has already commenced work on the terrestrial forms. I have been in communication with Professor von Graff on the subject for some time past, and have fortunately been able to send him a large number of our Victorian species in response to his request for material, and it would be a very great advantage if the land Planarians of all the other Australasian colonies could be investigated in time for the results to be incorporated in Professor von Graff's Monograph.

As land Planarians cannot be satisfactorily described or figured except from living specimens, it appears to me that the best plan is for local naturalists to describe and, if possible, figure the external characters—which are quite sufficient for the recognition of species—and then forward specimens in spirit to Professor von Graff for anatomical investigation and comparison. This is the principle upon which I have been working for some time past.

In order to facilitate the work of collectors in identifying already described species, I give at the end of this paper a bibliography of the Australian land Planarians.

2. Notes on some Tasmanian Land Planarians.

The only Tasmanian land Planarian hitherto described is, as already stated, *Geoplana tasmaniana*, collected by Darwin on the memorable voyage of the *Beagle*. The original description is quoted by Fletcher and Hamilton in their valuable "Notes on Australian Land Planarians."

The few specimens which I myself have to describe were collected in January, 1889, chiefly by my wife, near Hobart. It will be seen that, so far as present observations go, the land Planarians of Tasmania are very similar to those of Victoria.

Geoplana alba (Dendy).[1]

I identify, as a variety of this common Victorian species, a large specimen which I find described in my notes on the living worm as follows:—Length when crawling about four inches; colour on dorsal surface pale yellow, with big brownish pink tip at anterior end. Ventral surface white, brownish pink at anterior end; worm much flattened, very active, feeling about with horseshoe shaped anterior extremity as usual.

On careful examination of the spirit-preserved specimen, I noticed two points in which it differs from the Victorian specimens of *G. alba*—(1) I could find no eyes. In the Victorian specimens of *G. alba* the eyes are remarkably small and few as compared with those of other species. It is possible that the Tasmanian form has lost the eyes altogether, or, perhaps, as seems more probable, I have overlooked them in the spirit-preserved specimen. This is a point which I should much like to see determined by the examination of fresh specimens. (2) The ventral surface of

[1] Descriptions and figures will be found in Nos. 5, 6, 7 of the Bibliography.

the body (in spirit) appears distinctly marked out into three sharply defined though faintly coloured longitudinal bands, a median very pale yellow band, and on each side of it a band of about equal width of much deeper yellow. These bands cannot be conspicuous in life, for I have no record of them in my notes. The curious point about them is that they are so sharply defined, and do not merge into one another.

The shape of the worm in spirit is just like that of the typical *G. alba*, and the peripharyngeal aperture is situate nearly as far back as the junction of the middle and posterior thirds, while the genital aperture is placed at about one-third of the distance between the peripharyngeal and the posterior extremity.

The ciliated pits on the margin of the anterior extremity were distinctly visible in the spirit-preserved specimen.

A second, much smaller specimen, white all over when alive, with brownish pink tip at the anterior end, very narrow, and about 1½ inches long when crawling, appears to be a young specimen of the same.

Locality.—A moss-grown, rotten log, near the Silver Falls on Mount Wellington.

Geoplana adæ (Dendy).[1]

I identify a single small specimen as a slight variety of this species. In life the ground colour of the dorsal surface was whitish or pale greenish. In the middle line was a rather narrow band of ground colour, with a broad dark chocolate-brown stripe on each side of it. The ventral surface was whitish, speckled with pale greenish grey.

The only distinction which I find between this specimen and typical Victorian examples of *G. adæ* is the absence in the former of the thin median dark line. I refrain, however, from giving a varietal name until more specimens are to hand.

Locality.—A moss-grown, rotten log, near the Silver Falls on Mount Wellington.

Geoplana walhallæ (Dendy).[2]

As slight varieties of this species I identify two specimens, described as follows in my notes on the living worms :—

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[1] Descriptions and figures will be found in Nos. 5 and 7 of the Bibliography.

[2] Descriptions and figures will be found in Nos. 5 and 6 of the Bibliography.

(*a*) Dark olive-green above, with faint dark reddish speckles. Ventral surface greyish-yellow, with pale reddish speckles, except in the middle line. At anterior end of dorsal surface a thin median line of paler greenish or greenish-white. Length when crawling about one inch.

(*b*) Colour on dorsal surface dark chocolate-brown, speckled with green. No stripes. Ventral surface white, closely speckled with chocolate-brown. Very inactive, slug-shaped.

Locality.—A moss-grown, rotten log, near the Silver Falls on Mount Wellington.

Geoplana sp.

A single small specimen, about two-fifths of an inch long in spirit, and a little over one-twentieth of an inch broad. When alive the dorsal surface was whitish, closely speckled with light brown, and with a thin continuous brown median line. The anterior extremity was brown, and the ventral surface white. In spirit the ventral surface is much flattened, and the dorsal surface strongly arched; the peripharyngeal aperture is in about the centre of the ventral surface, and the genital aperture apparently about half way between the peripharyngeal and the posterior end, but not very satisfactorily determined.

This specimen appears to be related to our Victorian *G. quadrangulata*[1] and *G. ventropunctata*[2]. The shape of the body is more that of *ventropunctata*, but there are no specks on the ventral surface.

Locality.—Hill at foot of Mount Wellington, near Hobart.

3. Notes on some South Australian Land Planarians.

The two specimens described below were collected in November, 1891, at Norton's Summit, near Adelaide, by Mr. Thos. Steel, and forwarded to me in a living and healthy condition. It will be seen that one is identical with a Victorian species, and the other a variety of the same.

Geoplana fletcheri (Dendy).[3]

The specimen measured about 60 mm. long by 4 mm. broad when very fully extended. The body, in life, was

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[1] *Vide* Nos. 5 and 7 in Bibliography. [2] *Vide* No. 7 in Bibliography.
[3] *Vide* Nos. 5 and 7 of Bibliography.

much flattened beneath, but pretty strongly arched on the dorsal surface, except at the posterior end, which was a good deal flattened; much broader behind than in front. The peripharyngeal aperture (in spirit) is well behind the middle of the ventral surface, and the genital aperture rather nearer to it than to the posterior extremity. The skin is characteristically tough and wrinkling, as in the Victorian specimens. The eyes are numerous, arranged as usual at the sides of the head, and all round the anterior extremity. The dorsal surface, in life, was of a fairly bright yellow colour, with a single, very narrow, and somewhat indistinct median brown stripe, and numerous minute and faint dashes of brown all over the yellow ground, especially numerous at the posterior end. The anterior horseshoe-shaped extremity was of the usual burnt-sienna colour. The ventral surface was pale yellow, without spots or stripes.

Locality.—Norton's Summit, near Adelaide.

Geoplana fletcheri, var. *adelaidensis*, varietas nova.

The single specimen measured, when fully extended, 40 mm. in length by 2 mm. in greatest breadth. Body, when fully extended, long and narrow, strongly arched dorsally, flattened ventrally, tapering more gradually in front than behind. In spirit the posterior extremity becomes conspicuously broader than the anterior; the peripharyngeal aperture is situate at about the junction of the middle and posterior thirds of the body, while the genital aperture is rather nearer to the posterior end than to the peripharyngeal. The eyes are numerous, arranged as usual at the sides of the head and all round the anterior extremity.

The ground colour of the dorsal surface in life was pale, waxy yellow, with markings as follows:—In the middle line a very narrow but distinct longitudinal stripe of sienna brown; on each side of this a very much broader band of ground colour, measuring about one-seventh of the total width of the dorsal surface, and flecked with numerous small, irregular, longitudinal dashes of pale sienna; outside this a rather narrower stripe (but much broader than the median stripe) of dark, rich sienna, with ill-defined margins; then, extending to the margin of the ventral surface on each side, a broad band of ground colour, forming about one-fourth of the total width of the dorsal surface, and flecked with numerous small longitudinal dashes of pale sienna, especially abundant towards the outer margin; horseshoe-shaped anterior ex-

tremity rich sienna; ventral surface waxy white, with no markings.

Locality.—Norton's Summit, near Adelaide.

4. Bibliography of Australian Land Planarians.

(1.) 1844.—Darwin. (*Planaria tasmaniana*). Annals and Magazine of Natural History, vol. xiv., p. 246.

(2.) 1877.—Moseley. "Notes on the Structure of several forms of Land Planarians," &c. Quarterly Journal of Microscopical Science, N.S., vol. xvii., p. 273.

(3.) 1887.—Fletcher and Hamilton. "Notes on Australian Land Planarians, with Descriptions of some new Species. Part 1." Proceedings of the Linnean Society of New South Wales, series 2, vol. ii., p. 349.

(4.) 1889.—Dendy. "The Anatomy of an Australian Land Planarian." Transactions of the Royal Society of Victoria, vol. i., part 2, p. 50.

(5.) 1890.—Dendy. "The Victorian Land Planarians." Transactions of the Royal Society of Victoria, vol. ii., part 1, p. 65.

(6.) 1890.—Spencer. "Notes on some Victorian Land Planarians." Proceedings of the Royal Society of Victoria, N.S., vol. iii., p. 84.

(7.) 1891.—Dendy. "Additional Observations on the Victorian Land Planarians." Transactions of the Royal Society of Victoria, vol. ii., part 2, p. 25.

(8.) 1891.—Dendy. "Short Descriptions of new Land Planarians." Proceedings of the Royal Society of Victoria, N.S., vol. iv., p. 35.

(9.) 1891.—Dendy. "On the presence of Ciliated Pits in Australian Land Planarians." Proceedings of the Royal Society of Victoria, N.S., vol. iv., p. 39.

(10.) 1891.—Dendy. "Descriptions of some Land Planarians from Queensland." Proceedings of the Royal Society of Victoria, N.S., vol. iv., p. 123.

3.—FURTHER OBSERVATIONS ON THE EGGS OF PERIPATUS.

By ARTHUR DENDY, D.Sc., F.L.S.

In August last I read a short communication[1] before the Royal Society of Victoria in which I recorded certain observations which seemed to me to indicate that the common Victorian species of *Peripatus* (generally considered to be *P. leuckartii*) is normally oviparous, instead of, as in the case of all other observed species of the genus, viviparous. I also forwarded to *Nature* a letter on the subject, which appeared in that periodical on September 17.

The grounds upon which I based my conclusion were as follows:—On the 18th of May last I stocked a vivarium with male and female specimens of *Peripatus*. On the 31st of July I found that a number of eggs had been deposited (the total number deposited afterwards proved to be 15). These eggs were doubtless laid by the *Peripatus*, for there was nothing else present to lay them, and they agreed in size, shape and the nature of the contents with eggs which I have often found in the uterus of female *Peripatus*. Two facts strongly indicated that the oviparous habit was normal and not accidental: these were—(1) That I had dissected a good many specimens of the species at various times of the year and *had never found developing embryos* in the uterus, but only undeveloped eggs. (2) That the eggs, after deposition, exhibited a beautifully and regularly sculptured pattern on the outside of the shell; an observation, I believe, quite new for *Peripatus*, and reminding one forcibly of the eggs of insects. The eggs while still *in uterô* never exhibit this pattern, which appears to be formed as the egg passes through the vagina, and it is scarcely conceivable that such a pattern should be formed unless the habit of laying eggs were normal.

As considerable doubt has been thrown on the correctness of my conclusion that our common Victorian species of *Peripatus* is normally oviparous, I take the present opportunity of replying to my critics, and at the same time giving some additional evidence which has come to light since I last wrote on the subject.

In *Nature* of September 24, 1891, Professor Sedgwick replies to my observations by a short note in which he misses

[1] Proc. Royal Soc. Victoria, vol. iv., p. 31.

the whole gist of my argument. He says that "Mr. Dendy's observation of the extrusion of incompletely developed eggs in *Peripatus* is not, as he appears to think, entirely new. Captain Hutton was the first to observe it, in *P. novæ-zealandiæ*, and I confirmed his observation for the same species in my monograph of the genus. No one knows whether the eggs so extruded undergo complete development. I am inclined to think that the process, which has only been observed in animals in captivity, is an abnormal one, and is caused by the alteration in the conditions of the animal's life. We know that the New Zealand species does bring forth fully developed young."

This note somewhat misrepresents the nature of my communication, and entirely ignores the new observations which argue strongly in favour of my supposition, viz., the presence of a regularly sculptured shell, and the fact that in the Victorian species developing embryos have never been found in the uterus.

The fact that *P. novæ-zealandiæ* occasionally drops an egg abnormally appears to me to have little to do with the case. I suppose nearly all animals are liable to such an accident. It is universally admitted to be an abnormal occurrence in the New Zealand species, and Captain Hutton distinctly states that the eggs do not develop, which statement is quoted by Professor Sedgwick in his Monograph. Now, however, Professor Sedgwick says that "nobody knows."

I have next to deal with a criticism which demands more serious consideration. On September 30th, 1891, Mr. Fletcher read a note before the Linnean Society of New South Wales, in which, to quote from the abstract of proceedings, "he pointed out that whatever the Victorian *Peripatus* might be . . . *Peripatus*, as it occurs in N.S.W., is certainly viviparous; and in support of his statement he exhibited a series of twenty-eight embryos, just those which had come under his notice in the dissection of two or three females, or had been extruded during the drowning of several others, and comprising specimens old enough to show the full number of developing post-oral appendages up to individuals whose development is so nearly complete that they must have been within a very brief period indeed of birth; short therefore of actual witness of parturition he thought the evidence adduced was conclusive."

Professor Haswell also kindly wrote to me on the subject,

fully confirming Mr. Fletcher's observations on the viviparous habit of the New South Wales *Peripatus*. I think, therefore, that we may consider it as safely established that the New South Wales *Peripatus leuckartii* is viviparous. I still think, however, that the common Victorian species is *not* viviparous. Unfortunately I have not been able to obtain any Victorian specimens of *Peripatus* since I first observed the laying of eggs, although I have searched diligently for them. I have therefore been obliged to content myself with observing the behaviour of the *Peripatus* which remained alive in my vivarium and of the eggs which they had laid. I will take up the history where I left it in my communication to the Royal Society of Victoria. We will consider the fate of the adult animals first.

On September 16th there were still two females alive in the vivarium. I dissected one and found the organs apparently healthy and well developed. There was one large egg in the lower part of each oviduct, of the usual appearance, with a very thick envelope and full of yolk. No embryo was recognisable in either egg; both were cut open and examined microscopically. The shell was not sculptured. On October 1st the last surviving *Peripatus*, a female, was found dead in the vivarium. I found neither embryos nor eggs in the oviducts, but the internal organs were in a bad state of preservation; still the large eggs would have been recognisable. The ducts of the slime glands were very much enlarged and swollen out, and the branching parts very feebly developed,—in fact not distinctly recognisable. The alimentary canal was almost empty, and the animal seemed to have died of starvation.

It seems probable from these observations that these specimens, which I did not kill myself, died from starvation; there were a good many very minute insects present in the rotten wood, but these could hardly have been a sufficient food supply. This circumstance certainly favours the view that the eggs were abnormally deposited, but this piece of adverse evidence is, to my mind, completely outweighed by the fact that developing embryos are never found in the uterus of freshly captured females, and by the presence of the sculptured shell in the laid eggs. Moreover, if these eggs had been abnormally extruded, as in *P. novæ-zealandiæ*, it is very improbable that they would undergo development for any length of time outside the body of the parent; they would probably, as in the case of *P. novæ-zealandiæ*, perish.

Strange to say, however, although these eggs were laid before the end of last July some of them have gone on developing ever since and now contain advanced embryos! Can we suppose that an abnormally deposited egg would go on developing outside the body of the parent for more than five months? I had hoped that the eggs would have hatched out before the present meeting of the Association, but the development goes on very slowly and they have not done so. It is very possible that they never will hatch out, for they require constant attention in keeping the atmosphere just moist enough, and, unfortunately, some of them have been attacked by a fungus and destroyed. A few, however, are still evidently healthy, and the embryo can be dimly discerned lying coiled up within the thick, sculptured shell.

On November 30th I first noted distinct indications of an embryo coiled up within the egg, although some change had evidently been going on before then. The shell, however, was so thick and opaque that it was impossible to make out details. To make certain, on November 30th I dissected one of the eggs, and after cutting a piece out of the tough shell managed to remove a beautiful embryo *Peripatus*. The embryo was surrounded by a delicate thin transparent membrane, which closely fitted on to it and was extremely difficult to remove. I have also observed this membrane in undeveloped eggs; it is probably the vitelline membrane, and it lies inside the thick, sculptured shell.[1]

Microscopical examination showed that the embryo was in a very advanced stage of development. It had a distinct head with ringed antennæ, and the brain and eyes were clearly visible. There were also at least seven pairs of appendages present behind the antennæ. It lay coiled up in the egg with the posterior extremity against the side of the neck. I mounted the embryo in Canada balsam, and also the sculptured shell from which I removed it, and I shall be happy to show the specimens to any naturalist who wishes to see them. This embryo was removed more than a month ago, and, as already stated, I have some eggs in my possession still undergoing development, and probably now in a much more advanced condition.

I still hope that one or two of the eggs will hatch out, in spite of the fungus and the difficulties of keeping the conditions suitable. Even if they do not, however, I think the

[1] The term "shell" is perhaps rather misleading, as implying a hard brittle structure, whereas it is really a thick tough elastic membrane.

fact that they have developed normally outside the body for more than five months is pretty strong evidence in favour of the view that our *Peripatus* is normally oviparous. I do not wish, however, to be dogmatic on the subject ; I give the facts and prefer to leave others to draw their own conclusions from them.

There is one other question which I must refer to before I finish. If *Peripatus leuckartii* is viviparous in New South Wales, as has been sufficiently demonstrated by Mr. Fletcher and Professor Haswell, is it reasonable to suppose that the same species is oviparous in Victoria? But are we certain that our common Victorian *Peripatus* is *P. leuckartii* at all? I think not. There was already a certain amount of evidence in the nature of the markings on the skin of the animal for supposing that ours belongs to a distinct species; and the fact that ours is probably oviparous, and certainly lays an egg with a sculptured shell, while the New South Wales form is certainly viviparous, is another argument in favour of the distinction of the two. It may be remembered that when I first came across our common *Peripatus* in Victoria I suggested that it was probably distinct from *P. leuckartii*,[1] basing my conclusion on the peculiar pattern of the dorsal surface. Professor Sedgwick, however, promptly replied to my communication in *Nature*, and threw considerable doubt on the distinctness of the two forms. Mr. Fletcher also came to the conclusion that both belonged to *P. leuckartii*, and I myself, on examining more specimens, agreed with these two authorities. Hence our common Victorian species is now always known as *P. leuckartii.*

I think we may fairly consider, however, that recent observations have reopened the old question, and, for my own part, I strongly doubt whether the Victorian form belongs to *P. leuckartii* at all. The following are my reasons for supposing it to be distinct :—

1. I have shown in my "Observations on the Australian Species of *Peripatus*"[2] that in our Victorian form with fifteen pairs of legs there is a characteristic pattern on the dorsal surface, consisting of a series of segmentally arranged diamond-shaped patches in which the red colour is predominant. This pattern may, however, be reduced to a series of mere spots of yellow or red in some specimens.

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[1] *Vide Victorian Naturalist*, January, 1889, and *Nature*, 14th February, 1889.

[2] Proc. Royal Soc. Victoria, vol. ii., N.S., p. 50.

2. Mr. Fletcher states[1] that although in the only Victorian specimen which he had examined he found the characteristic pattern just as I described it, yet he has never seen a specimen from New South Wales with a similar pattern. It must be remembered that Mr. Fletcher and I have both examined a large number of specimens from our respective colonies.

3. *P. leuckartii* is undoubtedly viviparous, while the Victorian species is probably oviparous, and certainly can lay eggs with a beautifully and regularly sculptured shell.

4. Professor Spencer recently brought back from Queensland a number of specimens of typical *P. leuckartii*, some of which he most kindly permitted me to dissect and examine. We both came to the conclusion that there was a marked difference between the Queensland and Victorian specimens with regard to the appearance of the uterus and the intra-uterine eggs. In the Queensland specimens the eggs (none of which, unfortunately, were in an advanced stage of development) were much more numerous, much less regular in shape, and considerably smaller than in our Victorian specimens; they were also closely packed together, instead of occupying separate dilatations of the uterus as in ours.

These observations seem to me almost to justify the creation of a new species for Victoria, but I still prefer to await further developments. In considering this question care must be taken to avoid confusion between our relatively large, fifteen-legged Victorian form and our small fourteen-legged species. The former is the one referred to all through the present note, and is at present known as *P. leuckartii*; the latter is quite distinct, and has been described by me under the name of *P. insignis*[2]. I take the precaution of reminding naturalists of the existence of two totally distinct Victorian species, because some confusion has already unfortunately sprung up between them in an English periodical.

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[1] "Additional Notes on *Peripatus leuckartii*." Proc. Linn. Soc. N.S.W., 30th July, 1890.

[2] *Victorian Naturalist*, April, 1890.

4.—THE MARKINGS OF FISH WITH RELATION TO THEIR ANCESTRAL OR PHYLOGENETIC ORIGIN.

By W. SAVILLE-KENT, F.L.S., F.Z.S., *Commissioner of Fisheries, Honorary Member and Past President Royal Society of Queensland.*

The materials which form the subject of this paper having been primarily derived from investigations conducted in Tasmania, it has occurred to me that the outcome thereof might be most appropriately communicated to the Hobart meeting of the Australian Association for the Advancement of Science.

To the majority of the members present the peculiar and highly characteristic markings of all young individuals of the salmon tribe, including notably the Salmon, Salmon Trout, and the Common Trout, will be tolerably familiar and may be easily verified by a visit to the well appointed hatchery established on the River Plenty, within easy access of Hobart. All of the species of fish referred to are remarkable in their early life for the transverse bands, or so-called "par-markings" that are developed in a greater or less number throughout their bodies. As the fish grow older these par-marks gradually disappear and are replaced by the spots or other ornamental markings that characterise the adult fish. So late, however, as the so-called "Smolt" condition, representing that stage in the migratory or anadromous Salmonidæ, such as the Salmon and Salmon Trout, *Salmo salar* and *S. trutta*, when the body becomes clothed with silvery scales and the fish are ready to start on their journey to the ocean, the removal of the outer silvery coating displays again to sight the original par-markings, which have not actually become obliterated, but simply covered over by later developments. These markings are, in fact, both literally and figuratively more than "skin deep," and are of a far higher physiological significance than the ordinary stripes, spots, and other ornamental markings that blazon what may be termed the overcoat of the fully matured fish.

Interpreted by the light of the widely recognised laws of physiological evolution, the bars or par-markings shared alike by the young of so many representatives of the same family group signifies that all these now divergent members had a common origin, and that far away back in the primeval ages their common ancestor was a permanently striped or par-marked fish. This line of reasoning opens out a wide field

for speculative exploration concerning the particular race of fishes that gave origin to the now highly specialised Salmon tribe. This subject, however, is too extensive and abstruse a one to be dealt with on the present occasion, and one also apart from the more immediate objects of this paper.

The purpose of this present paper is to demonstrate how extensively corresponding deep-seated band-like markings are developed among other fishes, being, in a similar manner, most conspicuous in immature individuals, but frequently surviving in the adult fish, or remaining latent and capable of re-development under certain natural or artificially produced conditions. My earliest observations in this connection were conducted at Hobart during the tenure of my engagement as Superintendent and Inspector of Fisheries to the Colony of Tasmania, between the years 1884 and 1889, and in association with the aquarium and enclosed ponds for the cultivation of marine fish that, with the approval of the Government, were constructed to my plans at Battery Point. As that aquarium is still in existence, and I understand in working order, on the Museum premises, the opportunity will doubtless be afforded to members of the Association of verifying for themselves certain of the most interesting phenomena here placed on record.

The first and most interesting group of fishes to which I would direct attention is that for which Tasmania is so justly famous, popularly known as "Trumpeters," and referred by icthyologists to the family of the *Cirrhitidæ*. The so-called "Real" or Hobart Trumpeter, *Latris hecateia*, occupies par excellence, from a gastronomic standpoint, as members of the Association will have already tested, a foremost position in this highly-useful family group. As seen in its native element, or in the tanks of an aquarium, the Hobart Trumpeter is a wonderfully handsome fish. Its characteristic hues under such conditions are a ground colour of pale sea-green, upon which are superimposed a series of somewhat irregular longitudinal bands of dark olive-green, blended with yellow. In the event of living specimens of this fish not being accessible, I may refer to the coloured plaster casts representing this species, among many others, executed by myself from life and placed in the Tasmanian Museum. The special point to which I would direct attention is the longitudinal direction of the colour marks of this fish as seen under ordinary conditions. Happening one night to inspect the tanks by lantern light, I was greatly surprised to observe

that an example of this Trumpeter exhibited in addition to the normal longitudinal stripes a very distinct series of broad transverse bands of a dark grey hue. These transverse bands, some five or six in number, seemed to underlie the ordinary longitudinal series. On examining a number of specimens they were all found to exhibit the same peculiarity, and which fact demonstrated that the phenomenon was perfectly normal. Furthermore, all the Silver Trumpeters, *Latris forsteri*, the typical living daylight tints of which are a pearl-grey ground with golden or reddish-brown longitudinal stripes, were found to be decorated with similar supplementary transverse bands of a dark grey hue.

The most remarkable incident, however, associated with the phenomenon now brought under notice has yet to be related. It so happened that one of the smaller specimens of the Real Trumpeter, *Latris hecateia*, confined in a small shallow tank, was one night seized and mutilated by a cat in such a manner that the sight of both of its eyes were destroyed. While losing its eyesight its more essential vital functions were in no way impaired, and recovering from its wounds it floated quietly, though blindly, about its tank and took food, as previously, freely from the hand. With, however, the enforced interruption of the action of actinic light upon its optic nerves the fish assumed and permanently maintained that colour modification previously exhibited only at night. It would thus seem that the action of actinic light upon the optic nerves has a very distinct influence upon the appearance or suppression of the deeper seated colour bands now under consideration. The microscopic pigment cells of which these colour bands are ultimately composed become apparently contracted through the access of daylight to the optic nerves to such an extent as to be invisible to the ordinary vision. It was observed by me later on that these latent transverse colour bands became also temporarily visible under conditions of extreme nervous tension, and especially during the death throes of the fish when removed from their native element.

The next and more widespread occurrence of colour bands in fish to which I would direct attention is more permanent in character, and for the most part associated with young or immature individuals. In this connection it may be remarked that the Trumpeters that were the subjects of the foregoing observations were relatively young, representing that half-matured gregarious condition when they are popularly

known as "school fish." Young Sea Breams of the genus *Chrysophrys*, and of which the Silver Bream, *C. australis*, is a well known Tasmanian representative, afford characteristic illustrations of species that are distinctly cross-banded until their arrival at about one-half of their adult size. The so-called "Colonial Salmon," *Arripis salar*, a member of the Perch family, and very abundantly represented in Tasmanian waters, is conspicuous in its half-grown state for the series of gold-brown spots that decorate its sides. On a near examination these spots are found to exhibit a distinct transversely linear arrrangement. In the very young fish they in part present more or less the character of transverse lines, while in the largest adult individuals the spots or lines have almost, if not entirely disappeared. Fish of this type of ornamentation are especially interesting as illustrating transitory conditions between simply banded and diffusely spotted species. The Common Toad fish, *Tetradon hamiltoni*, and the Kelp Fish, *Chironemus marmoratus*, may be cited as familiar Tasmanian species in which transversely disposed series of spots or blotches replace the, in all probability, primarily distinct bands.

Looking somewhat further afield than the Tasmanian Fish-fauna, the number of species found to possess a transversely banded plan of ornamentation in their young, and also very frequently throughout their mature condition, is almost bewildering. There is, in point of fact, scarcely a natural family group from which some one or more members might not be selected, while in many instances it represents the dominant plan of decoration. Commencing with that family, the *Percidæ*, to which the front place is usually allotted in icthyological classificatory systems, no fitter illustration could probably be selected than the common English freshwater Perch, *Perca fluviatilis*, already acclimatised in Tasmania and Victoria. This fish, as it will be well remembered, is most conspicuous for the series of broad black transverse bands which decorate its sides throughout life, and render it one of the most handsome of British freshwater fishes. The Pike Perch, *Lucioperca*, of the Northern European rivers, is similarly ornamented. The true sea perches, represented by the host of species referable to the genus *Serranus*, or so-called "Rock Cods," of Queensland waters, include a number of forms in which from five to seven broad cross-bands are conspicuously developed. These bands, moreover, are in many instances under direct control, shining with greater or less

intensity in harmony with the nervous excitation of the fish. The Australian Red Mullets, referable to the genus *Upeneus*, are also frequently ornamented with corresponding cross-bands.

In the Sea Bream family, in addition to the genus *Chrysophrys* already noticed, the members of the genus *Lutianus* are commonly cross-banded, and the same plan of ornamentation is conspicuous, in the young more especially, of the typical "Schnappers," as represented by the genus *Pagrus*. The true Mackerels, family *Scombridæ*, are notable for a corresponding plan of decoration, the number of transverse body stripes in this group however, being usually extensive. The closely allied family group of the Horse Mackerels, as represented by the genera *Cybium* and *Chironemus*, are, for the most part, decorated in a similar manner, the cross-bands in the last-named genus being more usually, however, reduced to a series of ovate spots. The Sole family, or *Pleuronectidæ*, is one in which cross-banding is of somewhat rare occurrence, but here two Indian species known as Zebra Soles, *Synaptura zebra* and *S. cornutum*, may be cited in illustration of the same fundamental ornamental design. *Cynoglossus semipasciatus* and *C. puncticeps*, again, afford examples in the same family group of intermediate phases between the distinctly striped and wholly unstriped varieties.

There are numbers of fish in which the typical cross-banding plan of ornamentation is represented simply by a series of spots, and others that yield interesting modifications in other directions. The Indian freshwater genus *Barilius* is remarkable for containing a very considerable number of species, the majority of which are ornamented with either a series of par-mark like cross-bands, or an equivalent serial line of spots. One species, moreover, in this genus, *Barilius vendelisis*, is represented by three local varieties, one of which is plain-coloured, the second spotted, and a third transversely striped. A striped Herring has not so far been recorded, but there are many species, such as the Australian *Clupea sundaica* and the several European Shads in which a symmetrically developed line of spots remain, as vestiges of the stripes possessed by some extinct ancestral type.

Intermediate phases between typically striped and spotted fish are yielded by the genera *Barbus* and *Apogon*, and in both of which otherwise widely separated generic groups a singular uniform pattern of ornamentation predominates.

This in either genus consists in its most typical expression of three transverse cross-bands, the third or hindermost of which, at the base of the caudal fin, is commonly represented by a single spot. In the freshwater genus *Barbus* all three of the cross-bands may be represented by as many spots, while in both genera it commonly happens that the central and anterior cross-bands have entirely disappeared and a single tail-spot alone is left. This single tail-spot, the remnant of an original posterior transverse bar, recurs in a large and heterogeneous series of fish types. The single dark spot situated immediately behind the operculum or at the base of the pectoral fin in a correspondingly large number of species apparently represents in an equivalent manner the surviving trace of a pre-existing anterior bar.

One of the most singular modifications of the three-barred pattern referred to in association with the two genera *Apogon* and *Barilius* is met with in the Indo-Australian percoid type *Gengoroge sebæ*. In this fish the anterior and posterior bars converge superiorly towards the central one in such a manner as to produce in combination with it the contour of a conventional broad arrow; and the fish is hence known to anglers in ports of Queensland, where it is plentiful, by the suggestive popular title of the "Government Bream."

Examples of fish in which the normal series of transverse bars are separately divided up into a number of smaller spots, thus paving the way to the irregularly or profusely spotted types, are illustrated notably, among many others, by various species of the two Australian genera *Gerres* and *Pristipoma*.

The list already quoted might be indefinitely lengthened. A sufficiently long one, however, has been now brought forward to meet the object of this paper, and which is to direct attention to the evident orderly warp that lies beneath the complex and otherwise altogether incomprehensible overlapping weft of the colour markings of fish. To those who have the leisure and opportunities for picking up the threads of the somewhat tangled elements brought forward on this occasion, the subject may be commended as one well worthy of attention, and as calculated to bring to light data of high interest concerning the common ancestral or phylogenetic relationship of many fish that have been hitherto regarded as most remotely separated members of the same zoological class.

5.—NOTE ON A TREMATODE WITH CILIATED INTEGUMENT.

By WILLIAM A. HASWELL, D.Sc., *Professor of Biology, University Sydney.*

The presence of a coating of cilia is always laid down as one of the principal points which characterise the Turbellaria as distinguished from the class of worms most nearly related to them—viz., the Trematodes. In this respect the larvæ of certain of the Monogenetic forms of the latter class—*Epibdella, Udonella, Diplozoon, Polystomum*—help to bridge over the gap between the two groups; but in all of these the cilia are lost not long after the larva leaves the egg, and long before the sexually-mature condition is attained.

Certain of the species of *Temnocephala*, however,—a genus which in other respects occupies a quite isolated position among the Trematodes, afford us exceptions to this rule. Cilia are present on the surface of *T. minor* and *T. dendyi* (both of which frequent the surface of the common small Crayfish, *Astacopsis bicarinatus* of Australia) in the full-grown and sexually-mature condition. In the former species they extend over the greater part of the body, the tentacles and the sucker, however, remaining free from them. They are most numerous and most active immediately behind the bases of the tentacles; further back they become more scattered and are less constantly in action. In *T. dendyi* they are confined to a limited space behind the bases of the tentacles. Where they are present these vibratile cilia stand in marked contrast to a series of non-vibratile sensory cilia (the cilia of the "tactile cones") which occur along with them, being curved, highly flexible, and whip-like.

I do not consider that this discovery need alter to any great extent our views of the affinities of *Temnocephala*. Braun[1] lays great stress on the presumed absence of cilia in *Temnocephala* as separating that genus from the Rhabdocœle *Turbellaria*, with which he considers it to be in many ways allied; but, as he recognises, the integument of the *Temnocephaleæ* is quite different from that of the *Rhabdocœla* in other respects, save in the supposed absence of cilia; and in other parts of its organisation there is, as I hope to show in a detailed paper shortly to be published, not much real affinity between the two groups.

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[1] Brown's "Klassen und Ordnungen des Thierreichs," *Vermes*, p. 521.

6.—A REVIEW OF THE FUNGUS-BLIGHTS WHICH HAVE BEEN OBSERVED TO INJURE LIVING VEGETATION IN THE COLONY OF QUEENSLAND.

By F. M. BAILEY, F.L.S., *Government Botanist of Queensland.*

Perhaps no order of the vegetable kingdom has been more carefully studied than Fungi. Several of the most learned of botanists have spent the greater part of their lives in investigating plants of this curious and perplexing order, and it is from their labours that we at the present day are enabled to obtain some insight into the life history of forms which only a few years ago were hidden in obscurity. This has been more particularly the case with those forms of fungi designated "blights," and it is to plants of this class which have been seen to infest living vegetation in Queensland that I would at the present time draw attention.

I do not wish to pose as a noted mycologist, yet, having been the principal collector of these plants in Queensland, and also having by word and letter been the means of inducing others to collect, all of whose gatherings as they come to my hands I have forwarded with notes to European specialists, it may not be deemed presumptuous if I offer some few notes on a portion of the order, particularly as by the means I have adopted a very large mass of material has accumulated, and at the present this is being utilised by that pre-eminent mycologist, Dr. M. C. Cooke, in a work he has undertaken to prepare on the Australian Fungi, the various Australian Governments having jointly furnished funds to meet the expense of printing, illustrating, &c.

Although it is not my intention to refer to any colony but Queensland in this paper, yet, in noticing the work now in progress by Dr. Cooke, it is but just to pay the compliment of a reference to the indefatigable labours of Mrs. W. Martin, of Melbourne, who for the past ten or twelve years has done such good work in this field for Victoria, more particularly in that section called "blights."

I will begin my remarks by pointing out that there are a number of fungi which are thought to be blights, because they may at times, in certain localities where the circumstances are favourable to their development, be seen growing upon living trees or shrubs, but upon a closer inspection it will be observed that these are developed, not upon the living portions of the plants, but upon some exudation or dead matter,

such as wood, decomposed bark, &c.; such, therefore, should never be referred to as blights. The species of this habit are not restricted to any particular tribe or genus, for one meets with some of the largest forms of Agaricini and Polyporei in these situations. And, again, some amongst the moulds should not be classed as blights infesting living vegetation, although such may appear to be the case to the superficial observer. Such plants are rather means employed in the economy of nature for the utilisation of dead matter. Of course under cultivation dead or decaying matter is removed by the cultivator, and therefore fungi of the kinds above referred to are seldom taken any notice of, except in a botanic sense. The amateur cultivator, however, with which class Queensland is so well stocked, looks with alarm at many such species, and thus when he sees by his ill-cultivation that his young plants of tobacco, &c. are, as the gardener terms it, "damping off," he at once fancies that some new subtle fungus pest has attacked his crop, and he flies off to the mycologist to inform him as to the name of the particular fungus, and for some particular specific for its destruction. These misfortunes also occur to the cultivator of experience, but he will not accuse the innocent fungus which may be at the time found upon the rotting plants, and which has not been the first cause, but is only carrying out one of the first laws of nature in utilising matter. He will at once attribute the loss to its true cause, that he has not given sufficient attention to drainage, has sown too thickly, watered too freely or insufficiently, or some sudden change in the weather over which he had no control, but, having learned by experience, will do his best to guard against a future loss from a similar cause.

By some cultivators, whose practical knowledge of agriculture and horticulture is but limited, the deaths which frequently occur in plants of rapid growth during our summer time is attributed to some fungus, when no plant of this kind has had anything to do with the cause of death, and if a fungus is present it will be found to belong to those common to all decomposing vegetable matter. In all probability these deaths are caused by the root being overcharged with water; they become, as it were, "dropsical." Passion vines, pelargoniums, and many soft-wooded rapid-growing plants are very apt to die off in this manner in the months of October, November, and February.

I have been led to extend these remarks to probably a greater length than will be deemed advisable in a paper to

be read before your learned Society, but my official position brings me so constantly in contact with cultivators of the soil, many of whom seem to imagine that no practical knowledge is required to produce a successful cultivator; that all they have to do is when their crops are sickly bring a sample to some Agricultural Department, and that they will be there and then informed of the name of the disease and the remedy. This fallacy should be stopped at once, for it must be borne in mind that in husbandry theory and book information are of quite a secondary consideration—practice is the main factor in the case. The failure of so many who have started to cultivate in Queensland has been, in nine cases out of ten, their ignorance of the subject, and this is a science which can never be learned by listening to lectures, however common-sense and practical such may be. The art can only be obtained from actual practice; thus we should hail with joy the start made by the Australian colonies in forming agricultural and horticultural establishments where the art of husbandry will be fully taught.

With these few preliminary remarks I will proceed to record the various fungus blights which I have observed to attack living vegetation in Queensland during the past twenty years.

For convenience I have divided the kinds brought under notice into two sections,—in the first Epiphytes, and in the second Parasites. The former include those kinds which are found upon the leaves and twigs of plants, but derive little or no nourishment therefrom, the principal injury done by such being to smother the plants. Mr. Berkeley aptly remarks:—"It would be as rational to expect that plants would thrive under a brown bell-glass as to expect that vegetation should not be impaired where the greater part of a plant is covered with a thick dark felt." It would seem that these species derive their nourishment from the exudations of insects and the dust and dirt adhering thereto, not from the tree or shrub upon which they may be found; hence, when we from the name of a species might suppose it to have a preference for a particular genus, it will probably be found that an insect rules in the matter, not the fungus. Then, again, there are several fungi which live only upon the scale-insect infesting our trees and shrubs. For instance, we find the pretty little species *Microcera coccophila* and *M. rectispora* living on the above: these can scarcely be looked upon as plant-blights, except in a secondary sense.

Under the heading of Parasites will be found enumerated all those kinds which prey upon the vitals of the plants they attack. It is difficult, however, to draw a hard-and-fast rule in the matter, and it is not improbable that some species placed in this section should have been given in the first.

EPIPHYTES.

ANTENNARIA ROBINSONII, *Berk. and Mont*—This soot-like blight, which we are told infests ferns in the Island of Juan Fernandez, was a few years ago very thick on plants of *Baccharis halimifolia* in the Brisbane gardens. A. semi-ovata, *B. and Br.*, so common on ferns in England, is often abundant on a variety of garden shrubs.

ASTERINA ALSOPHILÆ, *Cke. and Mass.*—Found on the fronds of a fern tree, *Alsophila rebeccæ*. A. Baileyi, *B. and Br.* is met with on the foliage of *Hakea lorea* and other shrubs; A. epixera, *B. and Br.*, on leaves of *Mallotus philippinensis*, near Brisbane; A. pelliculosa, *Berk.*, on the leaves of *Trema aspera* in mountain scrubs, Queensland. It is also met with in Cuba, North America, and Ceylon; A. platystoma, *Cke. and Mass.*, very abundant at times on the foliage of the bean-tree, *Castanospermum australe*, near Brisbane; A. reptans, *Berk. and Curt.*—In Cuba this species was found on the leaves of a *Piper*. In Queensland it was met with at the Russell River on a *Eugenia*.

ASTEROMELLA EPITREMA, *Cooke*, infests the foliage of *Trema aspera* growing in mountain scrubs. A. homalanthi, *C. and M.*, is injurious to the foliage of *Homalanthus populifolius*.

CAPNODIASTRUM ORBICULATUM, *Cke. and Mass.*—This forms black cushion-like heaps on the foliage of the native shrubs in tropical Queensland, near the base of the Bellenden Ker range. So far as at present known this is its only habitat.

CAPNODIUM AUSTRALE, *Mont.*—This sooty blight is said to have been first found on the branchlets of Swan River conifers. It is also found on plants of the same order in Europe. In the Brisbane Botanic Gardens a few years ago it might be seen clothing, with its black felt, some large plants of cycas, completely concealing every particle of the green plant. C. ELONGATUM, *Berk. and Desm.*—This species often makes a rank growth on the twigs of plants, especially on those infested by scaly-bugs. Besides Queensland and

other parts of Australia this fungus is common to America and Europe.

FUMAGO VAGANS, *Pers.*—This, which in Europe infests the foliage of plants, has in Queensland been found on vine leaves.

LACHNOCLADIUM RAMEALIS, *Berk.*—In tropical Queensland the smaller branches of trees and shrubs are often found covered with this ramalina-like fungus, and is injurious to the host-plant similarly, but no more.

MELIOLA.—The following ten species of this genus are met with in Queensland in more or less abundance on the foliage of the plants mentioned, but never cover over the leaves like the *Antennarias* and *Capnodiums.* M. AMPHITRICHA, *Fries.*—Very abundant on the foliage of the indigenous shrubs. M. CORALLINA, *Mont.*, is in Queensland found on the foliage of shrubs in mountain scrubs. This species is met with on foliage in Chili, Juan Fernandez, and Cuba. M. DENSA, *Cooke*, was found on plant specimens sent from Queensland to Baron Mueller. M. EUCALYPTI, *Cooke*, was detected in the same manner. M. LOGANIENSIS, *Sacc. and Berl.*, discovered on the leaves of a *Similax* at the Logan River. M. MOLLIS, *B. and Br.*—Found on eucalypt leaves, forming dense soft black patches. In Ceylon it is met with on the leaves of *Eugenia jambolana.* M. MUSÆ, *Kunze*, on foliage in mountain scrubs. In Surinam it was met with on the foliage of Urania. M. OCTOSPORA, *Cooke.*—About the Brisbane River this is often to be seen on the foliage of the Brisbane box, *Tristania conferta.* M. POLYTRICHA, *Kalch and Cooke.*—This species, which is not uncommon in South Africa, has been found on the leaves of *Callistemon* at Gladstone, Queensland. M. TETRACERÆ, *F. v. M. and Thuem.*—Found on the foliage of *Tetracera wuthiana* at the Daintree River.

PARASITES.

ACTINOTHECIUM SCORTECHINII, *Sacc. and Berl.*—This species was found on the leaves of *Similax* at the Logan River by the late Rev. B. Scortechini.

ÆCIDIUM OR CLUSTER-CUPS are very rare in Queensland. Æ. APOCYNATUM, *Schwein*, has been met with on one of the Apocynaceous shrubs, but would seem rare, for this is the only time I can remember collecting it. Æ. NYMPHOIDEARUM, *B. and Br.*—This species is often far too abundant, and plays

sad havoc with the leaves of the pretty "Fringe Water-lily," *Limnanthemum indicum.*

AILOGRAPHUM MELIOLOIDES, *Cke. and Mass.*—Found on the leaves of native shrubs at Pimpama Creek.

ASCHERSONIA TAHITENSIS, *Mont.*—This small yellow epiphyllous fungus, which in Tahiti lives on species of *Cyrtandra*, has been in tropical Queensland met with on the foliage of a large climber.

ASCOCHYTA APIOSPORA, *Cke. and Mass.*, infests the leaves of a *Myrtus* in tropical, and a *Backhousia* in Southern Queensland. Another species, A. BRUNNEA, *Cke. and Mass.*, attacks the leaves of the Brisbane box, *Tristania conferta.*

ASCOMYCES DEFORMANS, *Berk.* (Exoascus deformans, *B.*), often destroys the foliage of peach trees. In Europe found to destroy the leaves of plum, cherry, peach, and almond.

ASTEROMA ROSÆ, *Lib.*—This discolours and injures the rose foliage in our gardens.

CERCOSPORA SOLANACEA, *Sacc. and Berl.*—This species was found on the leaves of *Solanum verbascifolium*, near the Logan River. C. VITICOLA, *Cess.*, which infests the vine leaves in Europe, has also been met with on vine leaves at Bundaberg.

CEREBELLA ANDROPOGONIS, *Les.*—This species, which in Europe destroys the inflorescence of Andropogons and Ischæmums, has been discovered on the inflorescence of the "Cluster Spear Grass," *Heteropogon contortus*, a closely-allied grass, at Gladstone, Queensland. C. PASPALI, *Cke. and Mass.*, infests the inflorescence of *Paspalum scrobiculatum*, and a form of this species is found at Gladstone on the "Kangaroo Grass," *Anthistiria ciliata.*

CHÆTOMIUM CYMATOTRICHUM, *Cooke.*—One of the "Bristle Moulds," has been found on the leaves of *Solanum Dallachyi*, at the Johnstone River.

CHÆTOPHOMA EUTRICHA, *Sacc. and Berl.*, was found at the Logan River on the leaves of the "Bean-tree," *Castanospermum australe.*

CLADOSPORIUM ASTEROMA, var. *minor*, *Cooke.*—This fungus forms the brown spots and patches which destroy so much of the foliage of the Grape vines in Queensland. C. HYPOPHYLLUM, *Feht.*, was found in Brisbane on the leaves of a *Serjania.* In Europe it infests the underside of the leaves of the common Elm. C. STENOSPORUM, *B. and C.*, is found both in America and Australia on the leaves of Pear Trees.

CONDRIODERMA DIFFORME, *Per.*, was found infesting grass on the Darling Downs.

DIMEROSPORIUM PARVULUM, *Cooke*, was found on the leaves of *Trema aspera* at Yandina.

DIPLODIA LICHENOPSIS, *Cke. and Mass.*—This species, in some localities near the Brisbane River, completely destroys the foliage of *Acacia complanata.*

DIPLODINA DENDROBII, *Cke. and Mass.*, infests the leaves of *Dendrobium speciosum* growing in bush-houses near Brisbane.

DOTHIDEA FIMBRISTYLIS, *B. and Br.* = PHYLLACHORA FIMBRISTYLIS, *Sacc.*—This was met with upon a species of *Fimbristylis* at Northcote, North Queensland.

DOTHIDELLA APICULATA, *Sacc. and Berl.*, found upon the leaves of *Litsea dealbata* in the southern parts of Queensland.

ENTYLOMA EUGENIARUM, *Cke. and Mass.*, was found destroying the foliage of a *Eugenia* at the Russell River.

EPICHLOE CINEREA, *B. and Br.*—When this fungus was first met with it was on an *Eragrostis* in Ceylon. In Queensland it seems to have a preference for species of *Sporobolus.*

EPICOCCUM SCABRUM, *Corda.*—In Europe this species is usually met with upon decaying stems of herbaceous plants. When found in Queensland it was upon some sickly plants of the common potato, and by the owner of the potato plants thought to have caused their decay.

EUROTIUM LATERITIUM, *Mont.*—This was detected upon some *Peperomia* specimens sent to Baron Mueller from Bartle Frere.

FUSARIUM DICIPIENS, *Cke. and Mass.*, and F. HYPOCREOIDEUM, *Cke. and Mass.*, are both met with on the leaves of the common rough fig *Ficus aspera* in the Brisbane River scrubs. F. RUBICOLOR, *B. and Br.*, at times does much injury to the foliage of Eucalypts in Queensland, seeming to have preference for the smooth-barked kinds.

FUSICLADIUM DENTRITICUM, *Wallr.* — In Europe this fungus infests the foliage of many Rosaceous genera. So far in Queensland it has only been met with on *Pyrus.*

FUSICOLLA INCARNATA, *Cke. and Mass.*—Found on the foliage of the indigenous shubs near the Brisbane River.

GAMOSPORA ERIOSPOROIDES, *Sacc. and Berl.*—Found on leaves at the Logan River.

GLŒOSPORIUM CITRICOLUM, *Cke. and Mass.*—Found on the foliage of Orange tree at Toowoomba. G. CUCURBITARUM

B. and Br.—A most destructive kind to the fruits of Bananas and Melons. G. Denisonii, *B. and Br.*, found on the leaves of *Macrozamia Denisonii.* G. fructigenum, *Berk.*—This frequently does much injury to the Pear-fruit both in Europe and Queensland. G. glaucum, *Cke. and Mass.*—This species at Nerang Creek forms large bluish patches on the leaves of the native shrubs. G. intermedium, *Sacc.*—This may frequently be met with on the decaying foliage of plants of the Citrus family in other parts, but in Queensland it is found on the native *Hoya.* G. lagenarium, *Pass.*, which in Europe attacks the fruits of Melons and Cucumbers, in Queensland is very destructive in some seasons to the Mango fruit. G. Lindemuthianum, *Sacc.*—This in some seasons does much damage to the French Beans and Peas. G. musarum, *Cke. and Mass.*—A few years ago this fungus was extremely bad on the Banana fruit, causing them to be dry and tasteless. G. pestiferum, *Cke. and Mass.*—This most destructive blight, about a year ago, was found on some Grape-vines at Rockhampton.

Graphiola phœnices, *Poit.*—This is a great pest to Date-palms in our gardens, and will probably interfere and cause loss when this Palm is planted for the sake of its fruit. I have never met with this fungus on the indigenous Palms.

Hamaspora longissima, *Korn.*—This destroys the foliage of one of our indigenous "Blackberries," *Rubus moluccanus*, and has been observed upon leaves of plants of the same genus in South Africa.

Helminthosporium inconspicuum, *Cke. and Ell.*—This fungus, which in several parts of America is found on the Maize, has been met with in Queensland upon the Orange trees. H. Ravenelii, *Curtis*, which in America is known as the "Blackseed," in Queensland is very abundant on the inflorescence of various grasses, especially the Sporobolus.

Hypocrella axillaris, *Cooke.*—This species was found to be very bad on an *Eragrostis* at the Walsh River.

Isariopsis clavispora, *B. and C.*, attacks the foliage of the American varieties of Grape-vines both in America and Queensland.

Lembosia graphioides, *Sacc. and Berl.*—This is found on the foliage of the "Billan-billan," *Olea paniculata.*

Macrosporium peponicolum, *Rabh.*—In the year 1888 much of the Papaw fruit in Queensland was injured by this fungus. In Europe it is said to do much harm to

Pumpkins and similar fruits. M. TOMATO, *Cooke*, at times destroys the Tomato crop.

MELAMPSORA NESODAPHNES, *B. and Br.*—This species was found destroying the fruit of a Lauraceous tree at Yandina some years ago. M. PHYLLODIORUM, *B. and Br.*, often destroys the phyllodia of *Acacias* about Brisbane.

MELASMIA EUCALYPTI, *Cke. and Mass.*—This fungus often does injury to the *Eucalypt* foliage. It was first detected at Nerang Creek.

MELOPHIA WOODSIANA, *Sacc. and Berl.*—This species lives upon the phyllodia of the "Brigalow," *Acacia harpophylla.*

MICROPELTIS APPLANATA, *Mont.*, M. DEPAUPERATA, *Sacc. and Berl.*—In Queensland this species has been found on the foliage of the "Blue Gum Tree" Eucalyptus tereticornis. It is also met with, in Brazil and several other countries, on the leaves of plants.

MYRIOCEPHALUM CASTANOSPERMI, *Cke. and Mass.*—This fungus, a few years ago, did much damage to the foliage of the "Bean-tree," *Castanospermum australe.*

OIDIUM ERYSIPHOIDES, *Fries.*, O. LEUCOCONIUM, *Desm.*, and O. TUCKERI, *Berk.*, blight a number of plants. These "Mildews," although ruinous if allowed to spread at their free will, can easily be kept in check by the free application of the sulphur-bellows, especially at the first appearance of the fungus. OOSPORA APHIDES, *Cke. and Mass.*, was found at Ipswich on Aphides upon Pumpkin leaves.

PERICONIA NIGRELLA, *Berk.*, which in Europe is found on grasses, was discovered near Brisbane on one of the native *Andropogons.*

PERONOSPORA HYOSOCYAMI, *D'Barry.*—During the year 1890 the Tobacco plants in most parts of Queensland were more or less affected with this fungus. The loss of the crop where such occurred should not in all cases be charged to the fungus, for insects and other causes often had a hand in the matter. To check the ravages of this fungus bluestone and lime have been found to answer.

PESTALOZZIA FUNEREA, *Desm.*—This species in Europe is met with on the leaves and twigs of various plants. It has also been found on one of the Queensland Myrtles. P. GUEPINI, *Desm.*, which is known in Europe as the "Camellia leaf" fungus, from its being frequently found on the Camellia, during the last year destroyed most of the foliage of the "Red Ash," *Alphitonia excelsa*, a few miles from Brisbane.

P. UVICOLA, *Speg.*—This has been met with at Toowoomba on vine leaves; in Europe it is said to damage the ripe berry. P. VERSICOLOR, *Speg.*—At the Logan River this species has been found on the foliage of *Cupania anacardioides.*

PHOMA CORDYLINES, *Thom.*—This, which in Europe was detected on decaying leaves of *Cordyline australis*, has been found on the old leaves of *Crinum pedunculatum* in a Brisbane garden. P. DIPLOGLOTTIDIS, *Cke. and Mass.*, is at times abundant on the foliage of the Queensland "Tamarind-tree," *Diploglottis Cunninghamii.* P. GRAMINIS, *Vitt.*, was found badly affecting grasses at Ayrshire Downs, Queensland. In Europe it is found on species of *Poa.* P. NOTHA, *Berk.*, has been found on the twigs of native shrubs near the Brisbane River. P. PLAGIA, *Cke. and Mass.*,, was observed on some young Palms received from the Daintree River in 1888. P. PURPUREA, *Cke. and Mass.*, is in some seasons very destructive to the foliage of the Brisbane River Eucalypts and Tristanias, and P. ROSARUM, *C. and Ell.*, infests Rose-bushes both in Queensland and Europe.

PHYLLACHORA ALPINIÆ, *Cke. and Mass.* — This is destructive to the foliage *Alpinia cærulea* in many parts of Queensland. P. ASPIDEA, *B. and M.*, also infests the foliage of the same plant, but in Ceylon it is said to be found on a species of *Ficus.* P. CATERVARIA, *Berk.*, both in India and Queensland is found on the foliage of several of the rough-leuved kinds of Figs. P. NERVISEQUIA, *Winter*, was found on the leaves of Cordyline specimens sent from Rockhampton to Baron Mueller. P. RHYTISMOIDES, *Corda.*—This species, which infests the foliage of an Acacia in India, in Southern Queensland is found on the phyllodia of *Acacia penninervis*, and in tropical Queensland on the leaves of Figs.

PROTOMYCES MACROSPORUS, *Unger.*—In Europe this fungus attacks plants of several genera; so far it has only been found in Queensland on plants of *Hydrocotyle asiatica* growing near a swamp at Stanthorpe.

PUCCINIA CAULICOLA, *Tracy and Gall.*—This "Brand" or "Mildew," as plants of this genus are often termed, is met with in America on stems of *Salvia*; in Queensland some few years ago it was observed quite thick on the stems of *Hypochœris*, growing in the Brisbane town reserves. P. GRAMINIS, *Pers.* (including P. RUBIGO-VERA, *D.C.*), more commonly spoken of as "Red-rust," is often met with upon the indigenous grasses in localities far distant from where any cultivation has ever been carried on, thus proving that it is

truly indigenous to Queensland. It does not seem partial in its wild state to any particular genus or species of grass, but, so far as my observations go, it would seem to be only abundant on grass where water has become stagnant and soured the land. This should point to the desirability of having all cultivated land well drained and thus aerified and sweetened. The cereal crops suffer more from this fungus than from any other, and hitherto no remedy has been found to check its ravages. The reason why Queensland suffers more from this pest than other parts may probably be due to the great variability of her climate. In years like the last, with a continual fall of rain during the winter, the cereals have had the opportunity of making a gradual and steady growth, and thus becoming strong enough to resist to a greater degree the ravages of rust, and we find the past season's crop to have proved better than usual. It should be borne in mind that as a rule in Queensland the winters are dry and the summers wet, which is most certainly not favourable to the growth of the European varieties of cereals, and it is my opinion that if the Queensland farmer is ever to be a successful cultivator of wheat and allied cereals, he must select for cultivation only those varieties of the various grains upon which the rust parasite does not thrive, and for these kinds he must not look to Europe or America, but rather to the parts of India where the climate in most respects resembles that of Queensland. P. HELIANTHI, *Schwein*—This pest, which destroys the foliage of plants of "Sunflower" both in America and Europe, made its appearance a few years ago on plants of this genus *Helianthus*, at Ipswich, and since then has been too abundant also about Brisbane. P. MALVACIARUM, *Mont.*—A pest to Malvaceous plants in Europe; last year destroyed the leaves of "Hollyhocks" in a garden at Toowoomba. P. RUMICIS, *Lasch.*, may frequently be seen on the leaves of "Docks" near Brisbane.

RŒSTELIA POLITA, *B. and Br.*—This curious fungus at times deforms the shoots of "Dogwood," *Jacksonia scoparia*, but is of rare occurence.

ROBILLARDA SESSILIS, *Sacc.*—In Europe this is said to be met with on species of *Rubus*. In Queensland it has been found on vine leaves.

RHYTISMA FILICINUM, *B. and Br.*—This, which may so frequently be seen spotting the fronds of ferns in Queensland, was first detected on a species of Alsophila at Ceylon. When first discovered in Queensland it was on the fronds of

a species of the same genus. R. HYPOXANTHUM, *B. and Br.*, at times quite destroys the leaves of *Cudrania javanensis* in North and South Queensland. Those persons, however, who go into ecstasy over variegated foliage would probably consider this fungus added a beauty to the Cudrania bushes.

SEPTORIA OLEANDRINA, *Sacc.*—This fungus may at times be seen on the Oleanders, but is not at all common. It is found on the leaves of the same genus in Europe.

SOROSPORIUM ERIACHNES, *Thüm.*, was found on the inflorescence of one of the Queensland species of *Eriachne.*

SPHÆRELLA DAMMARÆ, *B. and Br.*—Found on young plants of *Agathis* (*dammara*) *robusta*, received from Fraser's Island. S. DESTRUCTIVA, *B. and Br.*—During some seasons this fungus is very injurious to the Lucerne crop, more particularly on fields which have been many times cut, or the land undrained. The presence of the blight is at once known by the large number of flies it seems to attract, in fact it was the flies which drew my attention to it in the first instance about twelve years ago. S. RUBIGINOSA, *Cooke*, was found on leaves of *Pittosporum rubiginosum* from the Johnstone River. S. SMILACICOLA, *Schw.* which is met with in North America on the foliage of *Smilax*, was also detected on the plants of that genus and Dioscorea, near the Logan River. SPHÆRIA (DEPAZEA) LITSEÆ, *B. and Br.*—This some years quite destroys the older foliage of *Litsea dealbata.* S. (SUBTECTA) MACROZAMIÆ, *B. and Br.*—The nuts of *Macromzamia Hopei* at the Daintree River are often nearly covered by this fungus. S. POLYSCIA, *B and Br.*, is also frequently found disfiguring various kinds of gourds grown for ornamental purposes.

SPHÆROPSIS ROSARUM, *C. and Ell.*, which in North America is found on the branches of Rose-bushes, has been met with at the Logan River in Queensland on the same kind of plants. S. TRICORYNES, *B. and Br.*, infests plants of *Tricorynes anceps* in Northern Queensland.

SPHÆROTHECA PANNOSA, *Lev.*—This, the conidiophorus condition of *Oidium leucoconium*, usually known as "The Rose Blight," and which is found in all parts of the world where these plants are grown, attacks the Rose-bushes in Queensland, and has a high time of it, for, so far, I have never seen anything done to check its ravages. At the present time (November) most of the Roses about Brisbane are covered by a thick veil of this blight, although, had the sulphur-bellows been freely used upon the bushes at an earlier

stage of the fungus's growth, it might have been kept under, if not entirely eradicated.

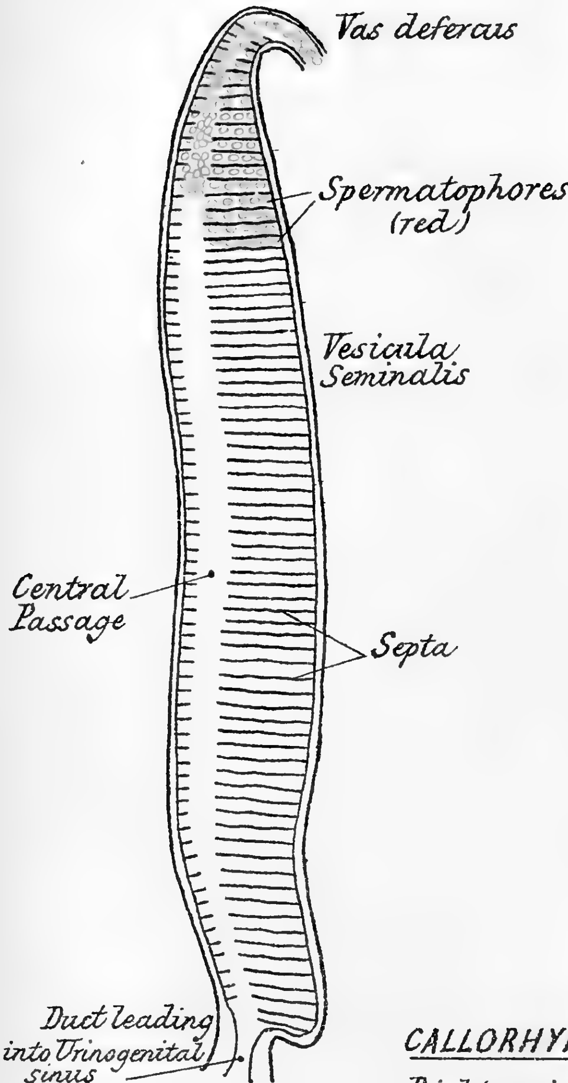
THECAPHORA GLOBULIGERA, *B. and Br.*—This species infests the inflorescence of the "Rice-grass," *Leersia hexandra*, about the Brisbane River, and it may be surmised that in after years the same fungus will do damage to the Rice crops.

TILLETIA CARIES, *Tul.* (T. TRITICI, *Bjerk*).—The well-known "Stinking-rust" or "Bunt," which fills the wheat grains with its fetid spores and threads, is more or less prevalent, depending mostly upon the care bestowed in pickling the seed. T. EPIPHYLLA, *B. and Br.*, attacks the leaves of Maize, but has not been observed to cause much injury to the crop.

UREDO CICHORACEARUM, *Dc.*—In the years 1886 and 1887 was very bad on Bidens pilosa and a few other weedy plants of Compositæ, but I did not observe it on plants of the same order in cultivation, and when found on the above plants it seemed only those growing on sour land. U. MAYDIS, *Batsch*, was very prevalent on Maize at Toowoomba in 1887.

UROMYCES AMYGDALI, *Cooke.*—The "Peach-leaf Rust." This fungus has been of late years very abundant on the foliage of the Peach and allied trees in Southern Queensland. U. DIPLOGLOTTIDIS, *Cke. and Mass.*, a few years ago was very destructive to the foliage of the "Queensland Tamarind Tree," *Diploglottis Cunninghamii.* U. PHYLLODIÆ, *Cke. and Mass.*, frequently is met with on the phyllodia of Acacias near Brisbane.

USTILAGO AXICOLA, *Berk.*—This smut at times completely destroys the inflorescence of a few species of Fimbristylis, and may be observed particularly bad on low flat undrained land. A similar smut, probably the same, is found on a Cyperaceous plant at St. Domingo. U. BROMIVORA, *Tul.*—This common species has been observed near Brisbane to injure the inflorescence of the common "Kangaroo Grass," *Anthistiria ciliata.* U. CURSA, *Berk.*, which in India destroys the grain of *Anthistiria arundinacea*, in Queensland has been met with, at the Walsh River, upon the inflorescence of *Anthistiria frondosa.* U. CARBO, *Tul.*, (U. SEGETUM, *Ditum.*), is found upon a number of Queensland grasses, often at a great distance from any cultivation. It infests the cultivated cereals in Queensland as elsewhere. U. CESATII, *Fisch de Waldd.*—This smut, which in America is found on the inflorescence of several grasses, in Queensland is usually met



T J Parker
Decr 1891

CALLORHYNCHUS ANTARCTICUS ♂

Right vesicula seminalis in longitudinal section Nat: Size.

Spermatophores shown in anterior part only.

with on *Paspalum scrobiculatum*. U. EMODENSIS, *Berk.*, in Queensland is found on the stipules of *Polygonum* near Brisbane. U. LEUCODERMA, *Berk.*—A species met with both in Borneo and St. Domingo, has been found on Sedges at Bundaberg, Queensland.

In concluding this review of the Queensland Blight Fungi, it would seem that some explanations or remarks become necessary. It may have occurred to many that a genus like Peronospora must be represented by more than a single species in a colony with such an extensive blight flora as Queensland, and such is most probably the case; but these kinds are only brought to our knowledge when their ravages are observed upon plants under cultivation, and may in many instances escape the cultivator's observation. It is also quite within belief that a large number of species of Peronospora and similar fungi are to be found abundant upon the indigenous vegetation, and that they will from time to time come from thence and fasten upon cultivated plants, especially when such are allied to those they may be living upon in a wild state. As we find in the animal kingdom the wild man preferring sheep to kangaroo, the flying-fox peaches to quandong, the grasshopper the more succulent vegetation of our gardens to the dry herbage of the plains, so in like manner we shall doubtless find from time to time blight-fungi, at present unknown, will come from the indigenous plants to exotic ones which may be more congenial to their development.

7.—PRELIMINARY NOTE ON THE VESICULA SEMINALIS AND THE SPERMATOPHORES OF *CALLORHYNCHUS ANTARCTICUS.*

By T. JEFFERY PARKER, B.Sc., F.R.S., *Professor of Biology in the University of Otago.*

(Plate.)

THE great size of the vesiculæ seminalis of *Callorhynchus* and the remarkable mode of aggregation of the contained sperms must have struck everyone who has dissected this extraordinary fish. I made some notes and drawings on the subject about eleven years ago, but owing to the pressure of other work laid the matter aside until now. The only published paper dealing with the question which has come under

my notice is one by Dr. E. C. Hobson, in the *Tasmanian Journal of Natural Science*, &c. for 1842. The publication appears to be a rare one, and I am indebted to the Rev. W. Colenso, F.R.S., for the loan of what I believe to be the only copy in this colony. Dr. Hobson's paper contains several interesting observations, although his morphological knowledge is of the slenderest.

In a full-grown male *Callorhynchus*, 75 cm. long, the vesicula seminalis is a dilatation of the vas deferens, about 12 cm. in length and 16mm. in diameter. It lies immediately ventrad of the kidney and epididymis, its anterior end being just mesiad of the posterior end of the testis. Anteriorly it communicates with the vas deferens, posteriorly it opens by a short narrow tube into the urinogenital sinus. It has a delicate sea-green colour, and the septa and spermatophores presently to be described can be seen through its thin walls.

A longitudinal section shows that the mucous membrane of the vesicula is produced into extremely delicate transverse septa, about 1 mm. apart, which divide the cavity of the organ into regularly arranged compartments. The septa are, however, not complete: towards one side of the vesicula seminalis they are interrupted so as to give rise to a narrow longitudinal canal along the whole length of the organ.

The entire cavity of the vesicula is filled with a clear pale green jelly of moderate consistence, which dissolves in water with much frothing, and hardens in alcohol without loss of colour or transparency. In this are embedded the spermatophores, globular or ovoid semi-opaque bodies, about 1 mm. in diameter, arranged in layers separated by the septa, but crowded together in the longitudinal canal mentioned above. Pressure upon the vesicula forces a small quantity of jelly with contained spermatophores from the canal into the urinogenital sinus.

Spermatophores also occur in the vas deferens and in the tubules of the posterior half of the epididymis, while the anterior portion of the latter contains free sperms. This is well seen by snipping off a piece of a tubule of the epididymus and squeezing out its contents on a slide: if taken from the anterior part of the organ a granular substance exudes, if from the posterior part fully formed spermatophores. In the specimens examined the only sperms which exhibited movement were some that had made their way into the urinogenital sinus.

The spermatophores are invested with a delicate membrane

which offers considerable resistance to pressure. Internally they consist of a clear semi-fluid substance in which numerous sperms are contained. The latter are aggregated into bundles, each of which consists of a considerable number of sperms arranged parallel to one another, and having about the distal third of their tails closely united together.

8.—A PROPOSAL FOR A SCIENTIFIC EXPLORATION OF THE ISLAND OF TIMOR.

By Lt.-Colonel LEGGE, F.Z.S., &c.

In bringing before the Members of the Association a proposal for an exploration of Timor, I am aware that I am advocating the undertaking of work on known ground ; and it may be asked, what is there of interest in this island compared with the grand territory of New Guinea, with its immense forests and lofty mountains, the home of the Bird of Paradise, and the cradle of mineral wealth? I answer, the exploration of New Guinea needs no advocating owing to the keen interest taken in the country of late years by Australians. A thorough carrying out of such work will no doubt be a very difficult matter, owing to the vast size of the island, the impassability of the Papuan forests, and the unhealthiness of its littoral climate ; but, nevertheless, as New Guinea is now an offshoot of Australia, its exploration is merely a matter of time, and our present knowledge of its zoological products will be materially increased within the next quarter of a century. Much has already been done in this direction by Messrs. Wallace and Salvadori, Drs. Fuisch and Meyer, and more recently by Australian naturalists, and in a country so interesting there will be no lack of effort and enterprise to add to our knowledge already acquired as regards both botany and zoology.

The island of Timor, however, offers a comparatively easy field for the naturalist and explorer. It has a fair climate, the Timorese are a peaceable people, the lowlands of the interior are considerably under cereal cultivation, the higher mountains are barren, and the country is chiefly under Portuguese and Dutch rule, all of which conditions render the zoological traveller's work far easier than in New Guinea. To the Australian naturalist Timor presents especial points of interest. The character of its vegetation

is in some respects similar to that of the continent, the hills near the shore being clothed with eucalypts, and there is a close relation between its birds and those of North Australia, sixteen Australian genera being found on the island, to which further exploration of the lofty mountain range will probably add a few more allied Australian forms. I apprehend, therefore, that the acquisition from an island closely related to our continent of botanical, entomological, and zoological collections for instalment in one or other of our great museums is a matter of the highest importance to the Australian biologist, inasmuch as it would be an important beginning to that knowledge of adjacent territory which in future years must of necessity be eagerly sought after by the scientists of a great Australian empire.

It may here be right to recapitulate what is perhaps known to most of us, viz., the zoological features of the Malayan chain of islands. Timor lies at the eastern end of the great Malayan chain, which Wallace first demonstrated to be divided in a remarkable manner into two very distinct zoological groups by the deep and narrow Lombok Strait, lying between the island of that name and Bali, which at one time must have formed a portion of Java. This strait, which is only 15 miles wide, is part of the eastern boundary of the expanse of deep water, exceeding 100 fathoms, which encircles the eastern end of the chain, and contains also within its expanse the island of Celebes, the Corean group, the Molluccas, and the western end of New Guinea. The great islands of Java, Sumatra, and Borneo lie in a shallow sea of less than 50 fathoms deep, which exists again close to the east end of Timor, and extends along the north coast of Australia and across to New Guinea. We see, therefore, that at present the whole of the chain from Timor to Lombok lies in a deep depression, up to the eastern border of which the continent of Australia at no very remote zoological period probably approached. And now comes the singular fact that the fauna of the eastern islands as far as the Lombok Strait has a decided Australian character, while on the opposite side of this narrow strait it is altogether Indian, and as distinct from the former as if the Javan portion of the archipelago were thousands of miles distant. It is not within the province of this paper to discuss the probable reasons for this similarity in the fauna of the Timor chain to that of Australia, but Wallace's theory that these islands have been upheaved from the deep sea between Java and

Australia, and have been gradually peopled by the fauna existing on either flank, seems to be the most reasonable one. At a subsequent period the land of North Australia and the adjacent sea bottom may have been elevated, although in more recent times the north coast of the continent seems to have undergone a submergence.

The island of Timor is 300 miles long and about 60 broad, and is traversed along its south-eastern shore by a high mountain chain, barren on its upper part, and entirely untropical in appearance; subsidiary ranges run outwards to the north coast, in the valleys, and on the slopes of which, at 3000 feet elevation, Wallace tells us, excellent wheat and potatoes are grown; but the productive character of the country is spoiled by the miserable system of cultivation adopted by the natives, and the apathy of the Portuguese in not opening up the country with roads. Wallace further remarks that "Sheep do well on the mountains, and a breed of hardy ponies, in much repute all over the archipelago, runs half wild, so that it appears as if this island, so barren looking and devoid of the usual features of tropical vegetation, were yet especially adapted to supply a variety of products essential to Europeans."

The Portuguese colony, of which Dielli is the capital, is situated at the north-east end of Timor, and the Dutch possessions are at the south-west, the chief town being Coepang.

In the early part of the century the island was visited and explored by the naturalist Robert Brown and other continental savans. Following them, Wallace spent four months at the Portuguese colony in 1861, and, as was his custom, collected largely, chiefly in the uplands of the interior, which he describes as being bare, and, where not cultivated, sprinkled with stunted eucalypts and other unluxuriant vegetation. He also spent a short time at Coepang at the western end of Timor, in the vicinity of which he found the vegetation scanty, although he testifies to an abundance of the fine "fan-leaved palms, *Borassus flabelliformis*," from the leaves of which water-buckets are made. In 1883 Mr. H. O. Forbes, a well-known botanist and naturalist, visited Dielli and collected for six months at the eastern end of the island. About 250 species of flowering plants were discovered by Mr. Forbes, the total number of species now known from the island being, according to Wallace, less than one thousand.

I am not aware that naturalists have explored to any extent the main chain of mountains flanking the south coast,

and it is the southern slopes of this range to which I would invite the attention of future explorers. It is probable that the foot-hills of those mountains may be clothed with a richer vegetation than the northern slopes already examined, and may yield some new species of birds, insects, and plants showing an affinity for Australian forms. The geological formation of this mountain range would perhaps yield some evidence in this direction, and the palæontology of the rocks throw a still more valuable light on the earlier connection of Timor with surrounding regions. The barren character of this range and its proximity to the coast would render their exploration comparatively easy.

I would therefore recommend the project for the consideration of Australian geologists and naturalists. No doubt the proper time of year for carrying out such an exploration would be between the months of May and November, when the season would be favourable for travelling, and important ornithological observations might be made on the movements of birds on passage to Australia along the coast of the island. The mammals, according to Wallace, are only six in number, and none of them are Australian. This fact, taken in conjunction with the presence of a partial Australian flora, presents a difficult problem for solution. The birds, which contain among them ten Australian species and twenty-six closely allied species, would have migrated to the island when the north-west coast of Australia was nearer than it is now, and which is certain to have been the case, as the shallow part of the Timor Sea approaches now within some 50 or 100 miles of the coast. That there has never in recent times been an absolute connection between the island and the continent is tolerably well proved by the afore-mentioned character of the mammals; but how are we to account for the similarity in the flora, and its dissimilarity with that of contiguous islands? These are questions which prompt my advocacy of a more careful exploration of the island than has as yet taken place. A point of interest in connection with the flora is the presence of a tropical and an Australian character in the vegetation, which is proved by the existence side by side of the *Borassus* and the *Eucalyptus*, and this union or meeting is analogous to the blending of an avifauna of these characters, viz., Malayan and Australian. As bearing on this branch of zoology, in which I am myself particularly interested, I may here transcribe Wallace's tabulation of the birds of Timor, which shows :—

Javan birds	11	Australian birds ...	10
Closely allied........	6	Closely allied	26
	—		—
TOTAL	17	TOTAL............	36

We have here a remarkable similarity in the number of species from Java and Australia, but a great preponderance of allied Australian species, which points to a similarity of climatic and food conditions.

9—ON THE AFFINITIES OF THE FLORULAS OF LORD HOWE AND NORFOLK ISLANDS.

By Professor RALPH TATE, F.G.S.

10.—ON THE SYSTEMATIC POSITION OF *BITHINIA HUONENSIS.*

By Professor RALPH TATE, F.G.S.

11.—ON THE PRESERVATION OF OUR NATIVE PLANTS AND ANIMALS.

By A. F. ROBIN.

12.—ON THE HABITS OF CERATODUS, THE LUNG FISH OF QUEENSLAND.

By Professor W. BALDWIN SPENCER, M.A.

13.—REVIEW OF THE QUEENSLAND LICHENS.

By J. SHIRLEY, B.Sc.

14.—LIST OF TASMANIAN MOSSES.

By W. A. WEYMOUTH.

15.—NOTES ON A YOUNG ECHIDNA SETOSA.

By A. MORTON.

Section E.

GEOGRAPHY.

PRESIDENT OF THE SECTION:

CAPTAIN PASCO, R.N.

1.—ON AN OLD MANUSCRIPT CHART OF TASMANIA IN THE RECORDS OF THE INDIA OFFICE.

By A. MAULT, *Hobart.*

(Two Maps.)

WHILE searching in the Indian Museum of South Kensington for some other charts connected with Tasmania, my attention was called to the second edition of Sir George Birdwood's Official Report on the old records of the India Office. Looking through it I found on page 77 the following entry :—"1643. A draught of the South Land lately discovered." It is described as a rough sketch, much damaged, and only held together by being backed with gold-beater's skin: and a foot-note adds that this must be a draught either of Van Diemen's Land discovered by Tasman in 1642, or of New Zealand. Through the kindness of Sir G. Birdwood and of Mr. Danvers, the Registrar and Superintendent of Records at the India Office, I was permitted to see and make an exact tracing of this "draught," which I at once recognised as being a chart of the discoveries made by the *Heemskirk* and *Zeehaan* under the command of Abel Tasman in 1642, and representing the same extent of the coastline of Van Diemen's Land as that on the charts given by Valentyn and by Burney as taken from Tasman's own. From this tracing I have reproduced in *fac simile* the accompanying "draught."

The "draught" is on paper, and is in the condition described in Sir George Birdwood's report. It has endorsed upon it, in writing of the style of the middle of the seventeenth century—"A Draught of the South Land lately discovered, 1643." I do not think there can be any doubt but that this endorsement was written by an Englishman;

Records of the India Office.

Endorsement:– (recent)

"1643

A draught of the South Land lately discovered.

"2d Last.

"13 - 9."

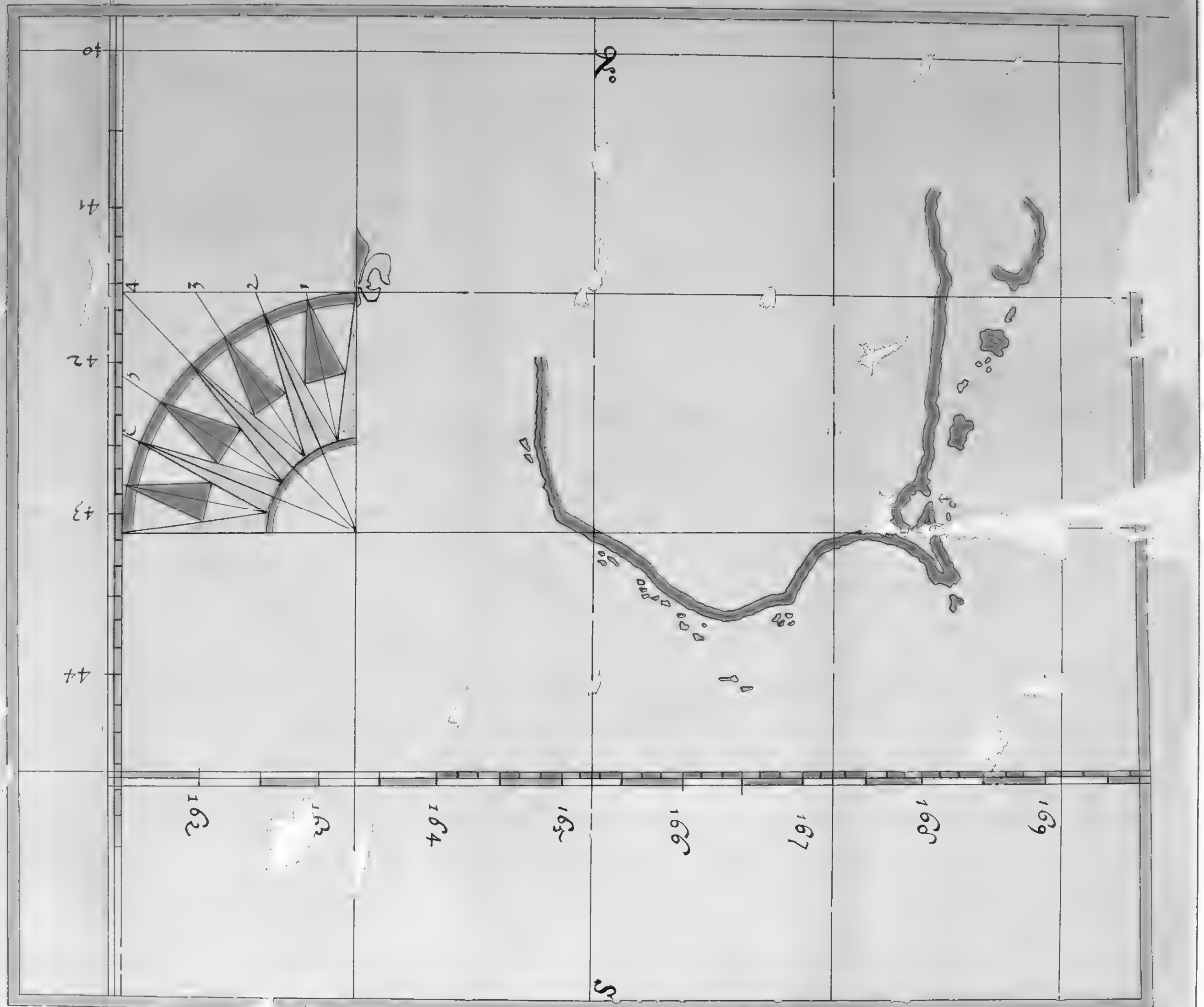
Original Endorsement:–

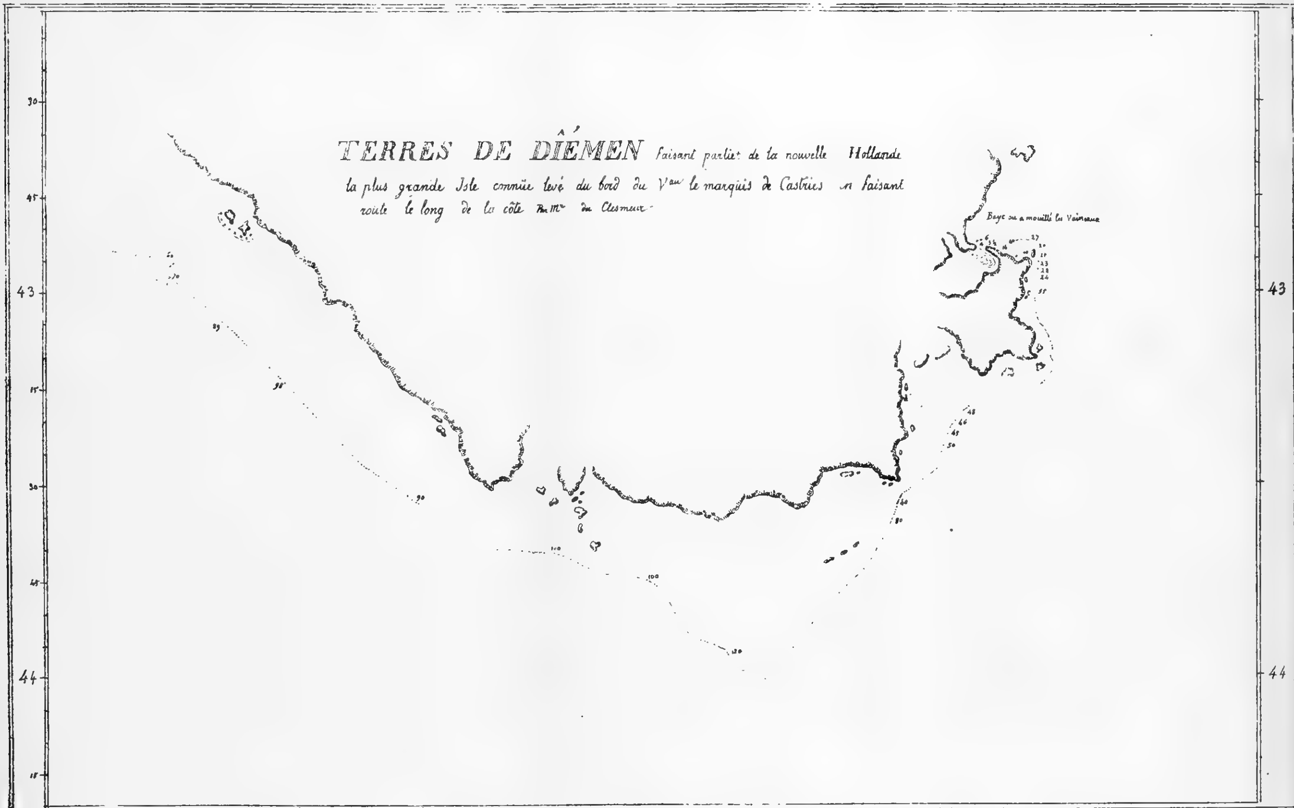
A Draught of the South land Lately Discovered 1643

Copied by

A. Meult.

Sept. 1891.




TERRES DE DIÊMEN faisant partie de la nouvelle Hollande
la plus grande Isle connüe levé du bord du Vau le marquis de Castries en faisant
route le long de la côte Par Mr du Clesmeur
Baye ou a mouillé les Vaisseaux
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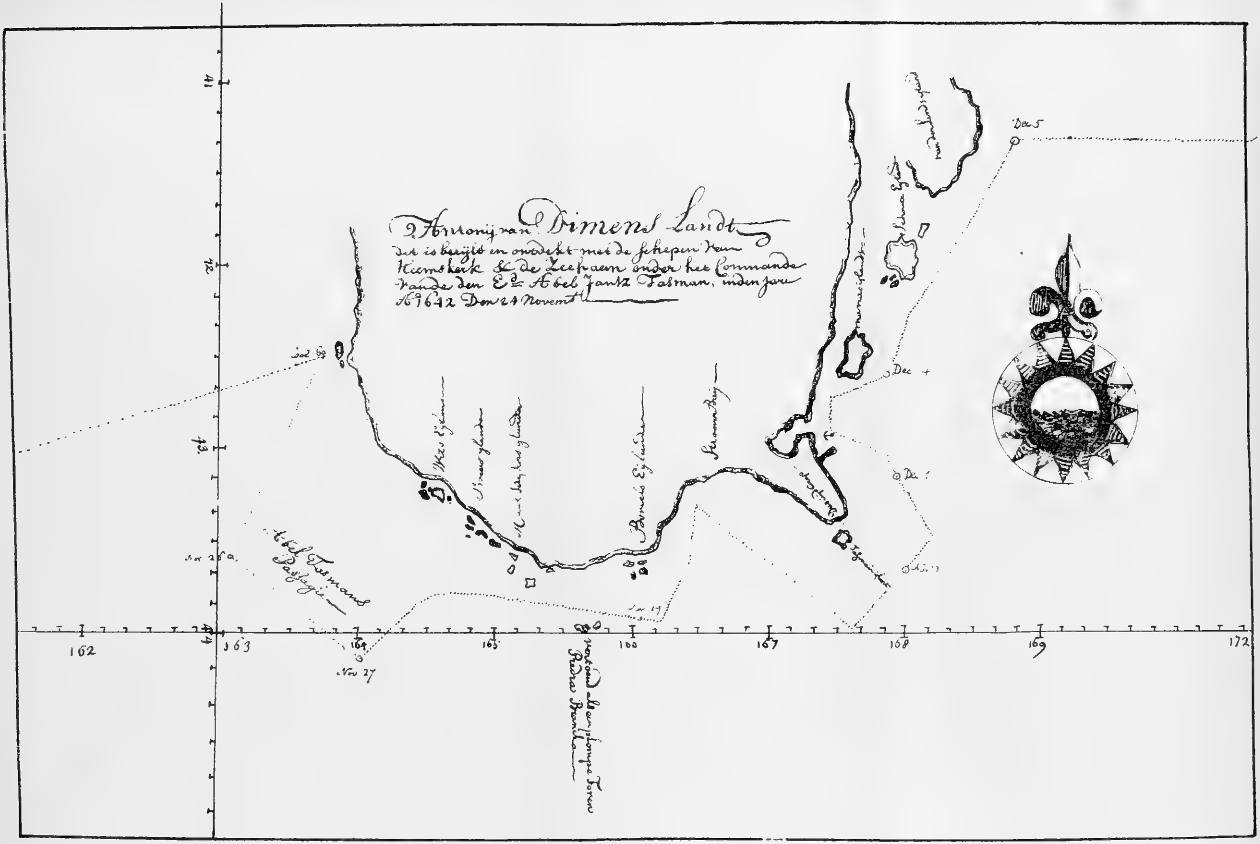

Antonij van Dimens Landt
dit is beseijlt en ontdekt met de schepen Heemskerk & de Zeehaen onder het Commande vande den Ed. Abel Jantz Tasman, inden jare Ao 1642 Den 24 Novemb
Abel Tasmans Passagie
Dec 5
Nov 27
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163
164
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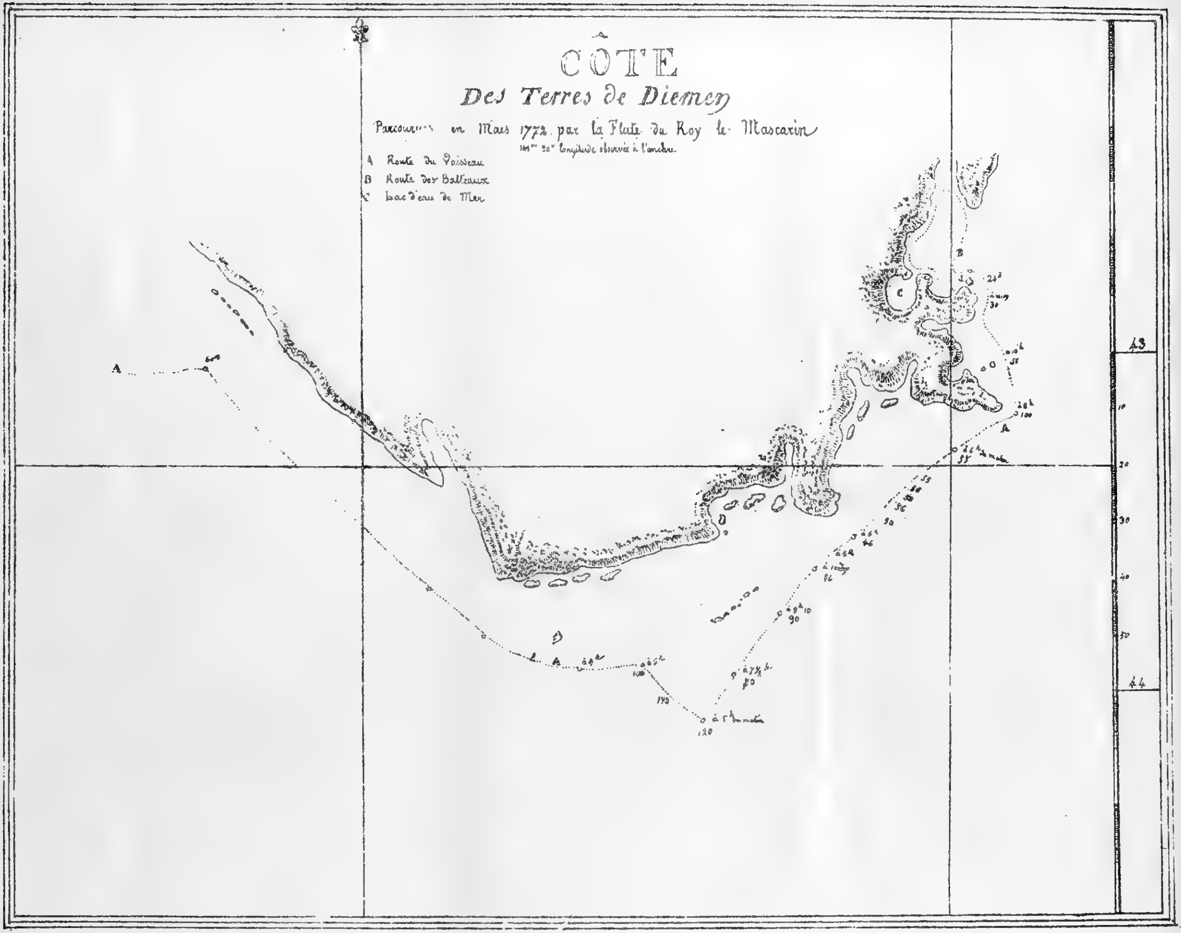
CÔTE
Des Terres de Diemen
en Mars 1772 par la Flute du Roy le Mascarin
A Route du Vaisseau
B Route des Batteaux
Lac d'eau de Mer
43
44

nor do I think that there can be any reasonable doubt but that it was written in 1643. The chart has marked upon it coloured scales of the south latitude from 40° to 45°, and of the longitude west from Teneriffe from about 161° 30′ to 169° 30′. A north and south line is marked on it, and on each side of this line rectangles are marked of about 90 geographical miles square, one of which is occupied by a quadrant compass. The lines defining these squares do not coincide with the degrees of longitude, nor with those of latitude, except in the case of the parallel of 40° south. There are no names written on the face of the chart; but the anchorage of Tasman, in what is now known as Marion's Bay, is marked. A glance at the chart will show that it represents the same land as that represented by Tasman's own chart. I could not learn in the India Office that there is any record of how it came into the possession of the Old Company. And when the jealousy with which the Dutch guarded the secret of their discoveries is remembered, and also the history of the publication of Tasman's charts, it is certainly very remarkable to find that a chart of the most important of his discoveries should have been in an Englishman's possession in 1643.

Tasman sailed from Batavia in the *Heemskirk*, with the *Zeehaan* in company, on the 14th August, 1642, and returned there on the 15th June, 1643. According to Burney, the first account known to have been published of his voyage was an abridgement of Tasman's journal published by Dirck Rembrandt von Nierop, at Amsterdam, in 1674. This seems to have been without maps. The "draught" in the India Office could not therefore have been copied from Rembrandt's work. The first published map of Tasman's discoveries was that in Valentyn's book printed in 1726, and it does not agree with the draught in all its details, nor does the character of the writing of the endorsement on the latter allow the supposition that it was written after 1726, even if no attention be paid to the date on it, 1643.

Furthermore, an examination of the draught itself will show that it was not copied from any other chart of which we have knowledge. As above said, it differs from the chart given by Valentyn. It differs equally from what is said to be Tasman's original chart as preserved with his journal in the British Museum (8946, Plut. CLxxiiD), a copy of which, taken from one made by Mr. Bonwick, accompanies this paper. The following differences will be noted between

this chart and the "draught." What were taken to be two islands off the point of land first seen are marked on the chart as one much larger than the other; on the "draught" they are much more equal in size. The mountain tops taken to be islands and called by Tasman Wit's Islands, are four in number on the chart, and three on the "draught." Sweer's Islands and Maatsuyker's Islands are differently placed in the relative position of each island to the others and to the mainland; and the same may be said with regard to the outlying Pedro Blanca and Eddystone. The shapes of Tasman's Island and of all the islands on the east side of Tasmania are different in the two maps. Cape Frederick Hendrick, which is shown pretty correctly on the chart, is represented as an island on the "draught." Neither Green Island in Marion's Bay, nor Ile des Phoques, north of Maria Island, are shown on the chart, but are both marked on the "draught." The whole of the land shown on the draught is placed about 45 minutes of longitude more to the eastward than on the chart, but the latitudes are about the same. The trend of the east coast is more directly northward in the "draught" than on the chart. Speaking generally, and with our exacter knowledge of the real position of the land, it may be said that the chart is more correct than the "draught."

Taking all the differences into consideration, it must be evident that the "draught" was not made, nor copied from one made, by the maker of the chart. By whom, then, was it made? It is of course impossible to answer with certainty: but I think the nature of the differences point to the conclusion that it was made on board the fly-boat *Zeehaan*, the consort of the commander, Tasman's, ship *Heemskirk*. We know from Tasman's journal that a chart or charts were being prepared and kept on the *Zeehaan* as well as on the *Heemskirk*, for they are mentioned in the Minute of Instructions sent to the officers of the *Zeehaan* on the 26th of November, 1642, after the Council meeting on board the *Heemskirk*. Two years ago I gave to the Royal Society of Tasmania copies of two charts made respectively on board the French ships *Le Mascarin* and the *Marquis de Castries*, in 1772, under circumstances similar to those of the *Heemskirk* and *Zeehaan* 130 years before, and the two French charts relatively show differences similar to those of these two Dutch charts.

As Tasman returned to Batavia in the middle of June,

1643, it was quite possible for any Englishman who may have been there at the time to have obtained by some means or other one of the charts, or a copy of one of the charts, on board the *Zeehaan;* and it is likely enough that he would try to do so, to secure in the interest of his own country such important information as it would contain. I know of no other way of satisfactorily explaining the English endorsement on the "draught" and its existence in the old records of the company that was just then establishing the foundations of its power in the east.

I think it will be safe to go a step further, and point out that in all probability this "draught" is not a copy but the original, or one of the original charts made on board the *Zeehaan.* I have called attention to the squares made upon it, one of which is occupied by the quadrant of the compass. The squares were made to facilitate the plotting of the chart from the compass observations, as is still done when parallel-rulers are not used. No one copying the chart would copy these squares, as they are of no further use when the chart is completed, seeing that the lines forming them are not, as I have remarked already, coincident with the meridians or parallels of latitude. Their presence on the chart is therefore evidence that the chart was made by their use, and consequently is an original chart. And that it was made on board the *Zeehaan* and not on board the *Heemskirk* is evident from the fact that it contains features, such as the Ile des Phoques, that were not seen from the latter vessel, as they are not marked on the charts made on board of it. This fact also makes it probable that the *Zeehaan* was much further inshore than her consort while sailing northward from the anchorage.

Another probability is that the chart was commenced before the Order of the Council held on the 26th November, 1642, with reference to the longitude to be adopted for a new departure, was communicated to the draughtsman, as that Order is not obeyed on the chart. If he was the official draughtsman of the ship he probably made another chart in obedience to the new instructions, and probably also the new chart was that kept as the official record. If this were so, it would greatly facilitate any Englishman's efforts to get this "Draught of the South Land lately discovered," as it would not then be considered as the ship's chart. The following is the Order of the Council as given in Burney:—"The officers of the *Zeehaan* are directed to mark in their

journals, longitude 163° 50′ for the land we saw yesterday, which we found it to be on comparing our accounts; and therefore we have fixed this longitude, and shall begin again from here to reckon the longitude. The commander of the *Zeehaan* is to give this Order to the steersmen. The maps also made of this land should place it in longitude 163° 50′ as before mentioned.

"Undersigned, ABEL JANSEN TASMAN."

2.—ICELANDIC NOTES.

By the Rev. J. B. W. WOOLLNOUGH, M.A.

THE paper I am about to read consists of little more than notes taken during a summer holiday. It makes no pretension to scientific value. Still, Iceland is all but "far as the poles asunder," whilst land and people are so unlike other lands and other races that I hope at any rate to interest you. The main idea I carried away from Iceland was that Nature had left her work there unfinished, and now, probably, never would finish it. Heat force is still hard at work. It is a land of volcanoes, sulphur and hot-water springs. There is lava everywhere. Within a mile or two, for instance, of Reykjavik, the capital, the track passes over bare level lava plains, like in appearance to our basaltic pavement at Eagle Hawk Neck, from thence to fields of lava-blocks of all sizes weathered into position, thence again to marsh land, where forests once stood, or to stretches of black volcanic sand. Walking in summer is therefore difficult, the more so as outside the southern and northern capitals there are no roads and but one bridge. Everybody rides. An Icelander jumps on his pony to compass the length of a street.

Cold has done much to stay the work of heat in making Iceland like other habitable lands. Just outside the Arctic Circle, the level of perpetual snow is but 3000 feet and some of the glaciers, I believe, reach the sea. An evidence of the close grip of heat and cold formed my first experience of this weird land. Coming on deck in early morning I found that Iceland was in sight, and that we were hugging the shore somewhat closely. A short distance from it towered up an ice mountain 5000 feet. From between its lower spurs a wide glacier ran down, apparently straight into the sea. Alongside, and yet wider, ran also a stream of lava, which in

past ages had sullenly forced its way from some volcanic centre hidden inland ; on the other flank the mountain fell in rugged black precipice, until it softened into the grassy bed of an upland valley, where the sun shone on a low farmstead and a large flock of scattered sheep.

The seaboard only of Iceland is inhabited, and an island larger than Ireland has a population of but 80,000, now decreased by emigration, to which the Icelanders have been compelled by the increasing rigour of the climate. Except where some poor pasture struggles up the valleys of the larger rivers, a lava desert covers nine-tenths of the whole island. In one part 4000 square miles are covered with one vast white mass of lava mountains, glaciers, and snow-fields. Elsewhere are isolated black hills, standing out of rugged lava plains, barren and waterless, interspersed with swelling belts of volcanic sand. Where patches of earth are found they are absolutely bare of vegetation, without even the tiny fern frond or willow shrublet, which, nearer the sea, may be found in the lava cracks, the one witness to the power of life in this great wilderness of death. Across the central desert there are three passes between the northern and southern capitals; but of these two are hardly ever, and the third but seldom used. Even of the habitable seaboard but one-third of the soil will grow even the coarsest herbage. From the seaboard plains rise abruptly here and there black detached conical hills of comparatively recent tufa, or long flat-topped basaltic ridges. In these plains there are many lakes, with low shelving banks.

The rivers, too, are many, running often within deep precipitous channels, with strong currents, fed by the snows of the central desert. Salmon, trout, and other fish abound, but in summer very persistent mosquitoes are a drawback to the pleasure of a fisherman.

Although black and white are the prevailing colours of Icelandic scenery, there is yet a third, the yellowish green of the scanty vegetation. The unenclosed pasture lands of coarse grass support 400,000 sheep and a large number of very diminutive but excellent ponies. This grass will not keep cattle, but a few are pastured in well-manured enclosures close to the farmsteads. The export of sheep and ponies has been of late years considerable, chiefly to Scotland. Here and there some bushes of willow and birch struggle for life, but there is only one tree throughout the south of Iceland, and no grain ripens. The Icelanders' bread is made of rye

imported from Denmark. Potatoes and turnips will ripen, but are little grown. Turf is the common fuel of the inhabitants, although fossil wood abounds.

I saw in sheltered places many wildflowers. Amongst those I knew were buttercups, violets, forget-me-nots, wild geraniums, thyme, dog-daisy, catchfly, and pink. Apart from cattle, sheep, and horses, there are few animals, wild or domestic. There are cats, and dogs not unlike the Esquimaux, clever as Scotch colleys in gathering in the ponies, but no pigs, ducks, geese, and until lately not even the domestic fowl. The blue fox is found, and a few imported reindeer. In hard winters a stray bear crosses on a Greenland icefloe, but is very inhospitably received. Amongst the birds ptarmigan are numerous, and I also saw plover, snipe, and snowbirds. The eider-duck is preserved with great care. Icelandic moss is widely distributed, whilst the double refracting Icelandic spar is found but in one spot.

There can be no doubt that the intensity of cold has much increased since the Norwegian nobles colonised Iceland in the ninth century. The Eyrbyggia Saga describes the settlement of the relatives of Thoralf, about 900 A.D., as rich marsh land, with thick woods between it and the mountains. Where these woods once flourished are now treacherous tussocky hillocks of rank grass rising out of quaking bog. Grain also could then be grown. The mean temperature now is in the south 47°, and in the north 33°, but during the summer, though the latitude of the north is 3° higher, the temperature is about equal. This is said to be owing to a branch of the Gulf Stream washing Iceland, with which the rain-clouds cross, brought by the prevailing southerly wind. These rain-clouds, as they pass over the island from south to north, meet a falling temperature and discharge their moisture before they reach the north, so leaving it the larger share of summer sunshine, and enabling its inhabitants to raise the earliest and heaviest hay crops.

There are eighteen intermittently active volcanic mountains in Iceland, and their eruptions have frequently done much mischief along the seaboard. The most terrible outburst was in 1783, when the Skapta Jokull threw out a mass of lava greater in bulk than Mont Blanc—greater, it is said, than has ever been known elsewhere in the world. It overwhelmed 1300 Icelanders, 20,000 horses, 7000 cattle, and 100,000 sheep. Its course is marked by two lava streams some forty-five miles long, seven to twelve miles broad, vary-

ing in depth from 10 feet to 600 feet in the sunken river beds. There was much discussion about the remarkable after-glow in 1884 which followed the volcanic eruption in the Straits of Sunda. The same phenomenon followed that of the Skapta Jokull, was speculated upon by Benjamin Franklin, and alluded to by Cowper in the second book of The Task. Hekla, the best known of the Icelandic volcanoes, is also the most active, having broken out about 25 times in the course of one thousand years. It is insignificant in appearance; a long sloping three-coned ridge of sand and slag, rising abruptly from a plain covered with sand and pumice, once fertile and inhabited. I ascended it three years after the eruption in 1878. The lava of 1841, the preceding eruption, was easily distinguishable by its glossy blackness and knobby vitrification. There is no crater like that of Vesuvius on the summit, which is almost flat. From it, on three sides, spread the lava of 1878 far towards the horizon, belching out still in many places intermittent volumes of smoke. It is needless to speak of the Geysirs, an exhibition of heat force often described, and of which we have the like in New Zealand.

I do not like to conclude even these brief notes without mentioning the high claims of the Icelander to the goodwill of geographers. A few Norwegian nobles with their Irish serfs, taking refuge in Iceland from the first King of Norway, became prominent in Europe from the ninth to the twelfth century as writers and poets, and not less as soldiers and merchants. They were also the great discoverers and colonisers of their age. The history of their Greenland colony, founded early in the eleventh century, is as sad as it is singular. It flourished for four hundred years, the last of seventeen bishops having been appointed in 1406; but communication with Iceland stopped in 1418, and when, in 1578, Frederick II. of Denmark sent an expedition to Greenland, every trace of the colony had disappeared. The Icelanders also discovered America, and in the Sagas accounts are given of voyages to White Man's Land, identified with Georgia and Florida; Helluland or Slate Country, probably Newfoundland; Markland, or Forest Country, thought to be Nova Scotia or Labrador; and New England, which the Icelanders called Vinland. In New England a colony was founded in 1007 consisting of 151 men and 7 women, and with it communication was kept up until the fourteenth century. In 1121 Pope Pascal II. consecrated an Icelandic

bishop, with jurisdiction over Iceland, Greenland, and Vinland, showing that the American colony was then well known. Thorwald, son of Erik the Red, and brother of Leifr who discovered New England, was killed there in a battle fought in 1002, and it is probable that the body of the Icelandic Viking, found in Massachussets in 1831 may have been his, buried in his armour as he fell. In 1008, one year after New England was colonised, the first child of European blood was born in America—Snorro Thorfinnson, son of the founder of the colony. From him, after the lapse of seven centuries and a half, descended Thorwaldsen, the great sculptor.

It may well be that we owe to the Icelander the rediscovery of America in the fifteenth century, seeing that Christopher Columbus visited Iceland the year before he sailed on his voyage of discovery, and there could hardly but have heard of the Icelandic American colonies. These Norsemen have given us some of our best blood, and although they have left us no more Americas to discover, we have in the proposed Antarctic expedition an opportunity of rivalling their exploits within the Arctic Circle one thousand years ago.

3.—MAGNETIC SHOAL NEAR COSSACK, WESTERN AUSTRALIA.

By Captain W. USBORNE MOORE, R.N.

The area of magnetic disturbance near Cossack exhibits all the characteristics of Red Magnetism, as if there was a congestion of the magnetic elements due to the South Magnetic Hemisphere. It seems appropriate, therefore, to call it a "magnetic shoal," and to treat it graphically as if it was an elevation or lump on the bottom of the sea, or area of "shoal" water, the magnetic soundings being deflections of the compass needle.

Worked out thus, it was found that the magnetic shoal developed the following features:—

An area four miles long north-east and south-west by two miles broad, with a depth of eight to nine fathoms at L.W. spring tide, bottom quartz sand, over which all compasses are deflected one degree or more.

Within the above, an area three miles long N.E. and S.W. by half a mile to one and a half miles broad, over which compasses are disturbed over half a point.

Within the above—

1. A line of maximum easterly repulsion over which the north-seeking end of the needle is violently repelled to the east, in one place as much as 56°.
2. A line of maximum westerly repulsion, over which the north-seeking end of the needle is repelled to the west, but only to the extent of one-half the easterly repulsion.
3. Between these two lines, which are from one to three cables apart, a line of no repulsion $2\frac{1}{4}$ miles long, over which the needle points to the true north, and the directive force is very small. This is called the "axis" or "line of vanished repulsion."
4. A point on this line about one mile from the south-west end of the magnetic shoal, where the intensity is greatest, which is called the focus.

The axis, or line of vanished repulsion, is inclined to the true meridian at an angle of 56° in the neighbourhood of the focus. This angle coincides with the amount of maximum easterly repulsion.

A vessel passing in a straight line across the magnetic shoal at the focus, on a north-westerly course, would find the north-seeking end of the needle behave in the following manner:—

When about one mile from the focus a slight disturbance would be observed, the north-seeking end of the needle being repelled to the east; but this disturbance would not amount to more than half a point until she had run to within $2\frac{1}{2}$ cables of the focus. The needle would then be more and more repelled until 300 feet from the focus, when it would be deflected as much as 56° from the true north. It would then quickly resume its correct position, and over the focus—for a hardly appreciable distance, say 10 feet—would point to the true north. After passing the focus it would be repelled to the west; and at 200 feet from the focus would be deflected as much as 26° from the true north. It would now begin to return again to its correct position, and at three cables from the focus on the N.W. side would not deviate from the normal more than half a point. At one mile from the focus all signs of disturbance would disappear.

Crossing the shoal rectangularly elsewhere than at the focus, similar but less powerful repulsion would be observed.

The distance between the largest east and largest west repulsion would be greater.

In a wooden ship or composite vessel like the *Penguin*, the compasses would act as usual after leaving the shoal. Whether induction would take place or not in an iron vessel is a matter yet to be ascertained. At present there does not seem to be any evidence that there is any danger to navigation, except that a vessel would be set out of her course if steering by compass when passing over it, more or less, according as to whether she cut across it at the narrowest part or obliquely.

The focus is in lat. 20° 32′ 35″ S., long. 117° 13′ 2″ E. From it Bezout Island summit bears S. 78° 49′ W., distant 2·17 miles.

The greatest range in the deflection of the compass card was 82°, after applying the deviation for the apparent position of the ship's head: the actual range, 86°.

The greatest inclination or dip, 81° 10′.

The greatest intensity or total force found was 18·808 (British units), or nearly double the intensity which, in this locality, is due to the earth considered as a magnet. This is the greatest known intensity generated by an invisible cause. The largest recorded intensity in the world, due to the earth considered as a magnet is 15·2 B.U., near the south magnetic pole.

The statement made by Captain Creak, F.R.S., the Superintendent of Compasses, that the north point of the needle is always repelled from the disturbing cause in the Southern Magnetic Hemisphere is fully confirmed by this investigation.

H.M.S. "Penguin," Admiralty Gulf, 20th June, 1891.

NOTE.—Commander Moore, in forwarding the above to the Admiral, states that "It seems probable that Captain Cook came across an area of disturbance like this when near Magnetic Island, off the coast of Queensland."

4.—EXPLORATION AND DISCOVERIES IN BRITISH NEW GUINEA SINCE THE PROCLAMATION OF SOVEREIGNTY.

By J. P. THOMSON, F.R.G.S.S., *&c., Hon. Sec. R.G.S.A, Brisbane.*

WHEN first invited to contribute to the literature of the Australasian Association for the Advancement of Science, a sense of prior duty to other kindred institutions almost forebade an acceptance. Considering, however, how intimately associated Australian interests are with the development of British New Guinea, and how closely connected the writer has been with the progress of exploration and discoveries made in that territory since it became part of the Empire, it was thought that the Hobart meeting would afford a favourable opportunity of placing before the public a brief *résumé* of what has been accomplished on behalf of scientific and commercial geography since the proclamation of sovereignty.

Although but three years have elapsed since Her Majesty's sovereignty was proclaimed over the south-eastern section of Papua, the writer knows of no other region in the Queen's dominions, representing the theatre of human energy for an equal period of time, that can be said to have yielded to science and commerce equal measures. And these will appear even more remarkable when we consider the limited resources available and the multiplicity of obstacles at all times associated with pioneering struggles in the midst of heathen people and an unknown region.

Her Majesty's sovereignty was proclaimed at Port Moresby on September 4, 1888, and since that date the work of exploration has been conducted without interruption. The first scene of Sir William MacGregor's operations in this connection was the archipelagos of islands off the south-east shores of the Papuan territory, known as Louisiade and D'Entrecasteaux. For years these islands had been the seat of feudal strife, tribal and intertribal warfare being the chief occupation of the inhabitants.

Public attention was first invited to this part of the Papuan land by the discovery of gold on Sud-est Land, and subsequently on the Island of St. Aignan. These goldfields are not extensive, nor have any very rich deposits as yet been discovered, but sufficient has been unearthed to keep a party of diggers employed during the past three years or so. It was chiefly for the purpose of establishing law and order that Sir William chose this part of the possession as the

initial point of his administrative labours. The gold obtained on Sud-est and St. Aignan was alluvial in character. The various islands grouped in this part of New Guinea waters were found to be of a mountainous character, in some places bold and precipitous, in other parts rugged and broken. Most of the hills, which consist of limestone and slate, appeared to have been early associated with volcanic action. On most of the larger islands traces of gold were found, and some of the creek beds and mountain faces showed strata of quartz and porphyry, and on Normanby Island this formation appeared to be associated with tin deposits. On Ferguson Island important discoveries were made. These consisted chiefly of thermal springs, saline lakes, sulphur vents, and subterranean channels, occupied by drainage water. In some of these cavities the stalactite formations were observed to be very beautiful.

The soil on most of these islands is very rich and fertile. Excepting that cleared by natives for planting purposes, the surface areas are clothed with forest and dense vegetation of less proportions. In several parts the native plantations occupied the steep faces of convenient hills and ranges, where regular terraces were cultivated for this purpose. Some of these were subdivided by saplings into small family allotments, great care and attention being bestowed upon their cultivation. The cultivated products consist chiefly of yams, taro, bananas, breadfruit, sugar cane, and sweet potatoes. It was on the island of Normanby that the Chinese banana was for the first time seen growing, as also the sweet potato. Besides ornamenting themselves the natives beautify their dwelling-houses by the cultivation of ornamental plants that grow in the villages. On the whole, these island inhabitants are remarkably healthy. A number of the adult population suffer from the usual forms of ringworm, and yaws are not uncommon amongst the children, but the more malignant forms of diseases, such as leprosy, phthisis, fever, ophthalmia, and elephantiasis do not apparently claim asylum with the islanders.

The garment of the sterner sex varies little in design and substance from that adopted by most of the savage races inhabiting the islands of the Pacific; their everyday toilet is not an elaborate one, and their wardrobe is stocked with the long narrow leaf of the pandanus, that is manufactured into a girdle which is fastened to the waist of the wearer by a cord, sometimes composed of human hair. It was common

enough to see their faces smeared with a dark pigment that always tends to increase the natural grotesqueness of their appearance. The women apparently endeavoured to vie with their lords and masters in artistic designing. Not being contented with the simple and easily varied form of besmearing themselves with pigment, they sometimes have recourse to the artifice of the tattooer. Their nakedness is covered by very thick grass petticoats extending extravagantly from waist to knee. Juvenile members of both sexes of the community affect the same form of dress as their elders do. Their domestic animals are limited to the dingo and pig.

An abominable practice, which will only be modified as British influence increases, obtains amongst these people of hunting the heads of their own kind, not merely in times of tribal warfare nor at the dictation of feudal strife, although the latter is by no means uncommon; but the occupation is a recognised one, and to all intents and purposes a legitimate institution fostered from childhood, so that to those concerned the hunting assumes the form of second nature; and no punishment is meted out to the perpetrators. The skulls are used in dwellings for ornamental purposes, where they are arrayed in conspicuous places according to their order of merit; in some villages the skulls are suspended over the front parts of the houses. Tribal hostilities are common, and it is not unusual to find neighbouring villages so unfriendly with one another that the fear of being killed prevents interchange of civilities. It may easily be understood that the social condition of these people is one of unconstrained savagery, and that Christianity is entirely unknown. Let us hope, however, that the powerful influence of the Wesleyan missionaries, to whom this part of the possession has been allotted, will bear good fruit, and that, instead of reverberating the fiendish yells of the heathen warcry and feast, the hills and valleys will henceforth re-echo the melodies of Christian harmony. The civil law is administered by a resident magistrate and a gold-warden, whose headquarters are at Samarai, in the Louisiades.

To the north of these groups lie the remote islands of Trobriand, Murua, and Nada, occupying a position between the parallels of 8° 25′ to 9° 23′ south latitude, and the meridians of 150° 30′ to 153° 40′ east longitude. These were visited and explored by Sir William MacGregor in July, 1890, and subsequently the central group of Murua was the scene of His Honour's operations, when its physica

conditions and resources were more widely investigated than on his former visit. Nadi is the name applied to the most easterly of these islands, the whole being only a few feet above high-water level. In this and the neighbouring groups to the westward are several secure harbours. While some of the islands are covered with excellent soil, admirably suited for the production of varieties of native food, the inhabitants of others are compelled to obtain supplies from indulgent neighbours. The dwellers are of Papuan type, active and intelligent. For arms they use the spear, shield, tomahawk, and knife; stone instruments being superseded by the more modern article from the blacksmith's forge. In dancing they are remarkably clever in the performing of graceful movements with the shield. They carve wood, and devote much time to fishing. The fish are caught in very large quantities, and cooked in wide-mouthed clay pots. In disposition Sir William found the islanders friendly and eager to trade. The Murua group, nearly half a century ago, witnessed the first struggles of the Marists in the noble and self-sacrificing cause of Christianity. These are recorded in the history of the first Melanesian French Catholic Mission, the disheartening trials of these messengers of the Gospel of Christ, in their fruitless efforts to christianise a refractory and freedom-loving tribe of Papuans.

It was while in this offshoot of the Possession that the opportunity was embraced of extending our hitherto imperfect knowledge of the north-east coast of the Papuan mainland, which is limited by East Cape on the east and Cape Ward Hunt on the north-west. *Apropos* of the latter, it may be well to state that since the visit of the late Sir Peter Scratchley, in the *Governor Blackall*, the promontory forming the coastal boundary of the German and British spheres had been known by the name of Boundary Cape, but that the old appellation has been reverted to by Sir Wm. MacGregor in deference to the wish of the Hydrographer to Her Majesty's Government. In general aspect the north-east coast is wild, lone, and weird, the mountain ranges being steep and rugged in most places, their flanks and leading spurs washing themselves in the limpid waters of the Pacific. No spacious harbours are to be found here, nor do the waters of the coastal slopes find their way to the sea by deep and wide river channels, such as those on the opposite side. To conduct a detailed survey of this part of the territory would require prolonged professional labour, but nevertheless many

important discoveries were made, and the details brought to light of that which formerly was very imperfectly known. An active volcano was discovered in the crown of Mount Victory, and several important features in the coastal formation were revealed. This part of New Guinea was some time ago associated with an unhappy occurrence, one of the native villages being entered and plundered of its store of ethnological objects, comprising implements of warfare and domestic utensils. But it will be gratifying to all true lovers of science and humanity to learn that one of the chief objects of Sir William MacGregor's visit was the restoring of these stolen articles to their rightful owners.

Generally speaking the coast line apportions itself into three great indentations known by the names of Goodenough, Collingwood, and Dyke Acland Bays, of little importance, however, to maritime enterprise as shelters to traders, cruisers, or the more spacious ships of Her Majesty's Navy. The coastal waters being studded with hidden dangers are not favourable to navigation nor attractive enough to induce pleasure-seekers to risk life and property in obtaining further information of their natural conditions. The greater part of this coastal country is of a mountainous character, especially so in the most easterly region, where mountains throw their outliers to the very water's edge, and the island, narrowing and shooting out, forms the long peninsula terminating in East Cape. This general aspect is, however, somewhat modified as the Anglo-German boundary is approached, where fertile valleys and open plains are at places met with. In places the country bordering upon the seashore is swampy and the soil sour; but this is by no means a characteristic feature, nor one likely to impede settlement. A remarkable feature in the coastline is the absence of even moderately sized rivers, a singularity that one is apt to view with astonishment. A glance, however, at the general topography of the country will effectually explain the phenomenon, for we see that the rugged and steep features of the landscape leave no drainage area of sufficient magnitude to create rivers of any importance. In character the vegetation of this region assumes no remarkable features, the foreshore being fringed with the usual evergreen mangroves, and the background clothed with the weird casuarina and the ordinary forest trees. In places the sago palm grows in the congenial swamps, and the majestic wavy head of the coco-palm towers over all other forms of vegetation. In the neighbourhood of villages, where these grow in

clusters, the aspect of the landscape is transformed to one of loveliness. Cape Nelson is chiefly noted for numerous indentations, forming very picturesque harbours of refuge for coastal vessels. These occupy the whole perimeter of the cape, and are separated one from the other by long narrow tongues of land, with the central ridges of moderate elevation. In the neighbourhood of these picturesque havens the country is thickly inhabited by people, who utilise the fringing reef for fishing purposes and cultivate the soil profitably. It is over this part of the possession that the Anglican mission's influence is now being extended; its territorial limits embrace the whole of the country between the Anglo-German boundary and Cape Ducie, where the Wesleyans join issue.

It is only natural to expect that over such an extensive coast line the variations in the general characteristics of the native inhabitants should to some extent be correspondingly great. In many places where no previous intercourse with Europeans had been held the people were friendly and confident, but outside those virgin fields shyness and distrustfulness were rampant. Some of the men wore false whiskers from ear to ear, their hair assuming the form of great mops and matted ringlets. Their ears were embellished with rings of various shapes, and their heads were decorated with feathers, shells, and fibres. It was somewhat remarkable that in the more westerly tribes a corset of network was worn by the women, while to the east of these the nakedness of the men was concealed by a similar garment. Of iron and other European articles of merchandise most of the coastal tribes knew nothing, nor were persistent practical demonstrations of their utility sufficient to induce them to view with favour what other neighbouring tribes would not hesitate to possess themselves of by murder, rapine, and plunder. In design and structure the dwelling-houses are similar over the whole of this region; their capacity is no larger than the immediate wants of each family require, and for domestic purposes they are inferior. An interesting feature was discovered in the neighbourhood of Cape Sebiribiri, consisting of a natural stronghold of probably 80 feet in height, composed of two huge masses of coral, with perpendicular faces. The culminating parts of these were occupied by several houses, to which access was obtained by wooden ladders. The eastern portion of this part of the possession witnessed the enactment of one of the most horrible tragedies ever perpetrated within the district. This occurred in Chad's Bay a few years ago,

when the *Star of Peace* was pillaged and her captain Ansell brutally massacred. The inhabitants proved themselves remarkable for their warlike disposition and refractoriness after the deed had been perpetrated. Occupying an advantageous position they succeeded in eluding the Administrator, who first occupied their villages, and, subsequently, Ansell's Peninsula, for several weeks. Sir William's movements, although wisely planned and skilfully conducted, were closely watched and aggravatingly evaded, and it was only by the aid of friendly disposed chiefs that the capture of Ansell's murderers was finally effected.

The eastern districts embrace the country between Port Moresby and East Cape. Part of this territory was known before sovereignty was proclaimed; but it was not until Sir William MacGregor's official duties took him on extended tours of inspection that we were able to obtain reliable information concerning the geographical character of the whole section, and the social conditions of the inhabitants. Of the former it may be said that in quality the same variety exists throughout that is met with in other parts of the possession. The basin of the Kemp-Welch comprises some fine agricultural and pastoral land, most of which, however, is occupied by the native dwellers. Vegetation is luxuriant; the conglomerate faces of the Astrolabe Range and its outliers are mantled by dense forest, and the lower ridges and flats are interspersed with patches of grass and timber trees, among which the well-known eucalyptus flourishes. The limestone hills are carpeted with nutritious pastoral grass, and the intervening valleys possess soil of very rich quality.

In the immediate neighbourhood of the seashore the country is thickly populated by a variety of tribal communities, but in the inland districts the people are scattered. For this reason much larger areas of country are unoccupied than in the more thickly settled coastwise regions. The inhabitants are divided into tribes, some large and others very small, but all more or less hostile to one another, consequently they are rarely at peace. From incessant incursions some formerly powerful tribes have been almost entirely exterminated, the remnants living a miserable existence in tree houses. This is notably the condition of the wretched Veiburi and Seme people, who for years have been persecuted by the hostile tribes of Manukora and Garia. Not satisfied with repeated assaults upon inferior numbers of men, the Manukora savages were eager to take advantage of poor defenceless women and

children. A most painful case of this kind was investigated by the Administrator shortly after his assumption of office. It was on the peaceful bank of a mountain stream that a native woman, accompanied by two little girls and a boy, were innocently wandering in search of food when they were brutally slaughtered, and their ghastly corses left on the gravelly edge of the stream to the ravages of the birds and beasts of prey. The forms of disposing of the dead are loathsome and repugnant to the civilised mind. In some places the remains are laid out on an unprotected platform where the elements are free to act on them. Sometimes the corses are suspended in the branches of trees in a position to allow the decomposed liquid to fall into a vessel, and others are laid out on platforms inside "dead-houses" within the villages. Upon the individual merits of these systems it is not intended to dwell; let us hope that as civilisation advances, these outrages upon the feelings of the living may be recorded as a thing of the past. The process of transition will no doubt be slow and tedious, but if the foundation we have already laid is steadily built upon the issues will be felicitous.

One of the earliest Government stations is situated at the village of Rigo, where the interests of the Crown are protected by a resident agent. This is not far distant from the seat of Government, but the site was an eligible one, and easily accessible either by land or by sea. One of the native teachers of the London Missionary Society also labours in this district, his head-quarters being also at Rigo.

Concerning the geological character of this region we know but little. Several specimens of rocks have been submitted to the examination of experts, but the results are incomplete, through inadequate representation. The specimens were chiefly pebbles and small pieces of quartz, jasper, lydianised quartz, limestone and oxide of manganese in a hard silicious matrix. In the district of Rigo indications of iron were met with, and specimens of plumbago of good quality were obtained. From his hurried observations Sir William MacGregor is of opinion that these plumbago deposits, which are scattered over wide areas within the district, may very probably be of considerable commercial value.

The Kemp-Welch basin is walled in on its northern aspect by the Obree Mount, the highest peak of an extensive and rugged range, the slopes of which are clothed by dense

vegetation. To scale this mountain peak was the ardent ambition of many an aspiring and adventuresome mind. Expeditions were organised and traversed the Kemp-Welch Valley, but it was not until Mr. Cuthbertson arrived on the scene that its hidden resources were brought to light. This explorer, who was the emissary of the Royal Geographical Society of Australasia, very pluckily succeeded in reaching an altitude of about 8000 feet, where surrounding objects were rendered difficult to observe by a dense curtain of fog. Although Mr. Cuthbertson from his position was able to observe the Peak of Mount Victoria, on the Owen Stanley Range, and to obtain a good view of the surrounding range, it is still a matter of doubt with some whether higher points on the Obree Range might not have been hidden from view by one of the numerous mist columns which so frequently obscure the subalpine zones of the mountain.

When Sir Wm. MacGregor first visited this district the people inhabiting its most easterly part were more warlike than those nearer the seat of Government. This was especially the case with the Cloudy Bay natives, who were associated with one of the most horrible tragedies ever witnessed in Papua. To those interested in New Guinea the shocking details connected with the massacre of Rochefort and M'Tier will still be fresh in the memory. Arriving in Cloudy Bay these two men, in quest of gold, were brutally murdered when in the act of crossing a small stream. When some time afterwards Sir Wm. MacGregor was on an expedition to the locality, he saw fragments of the skulls of the wretched victims to savagery lying on the bank of the stream. The villages of Merani and Isimare, situated on the Domara Wai, a small stream flowing into Cloudy Bay, were fortified by strong palisades and tree houses. The soil of the locality is very rich, the cultivated products plentiful, and the vegetation most luxuriant. Overlooking this locality are Mounts Suckling and Clarence. The former, some 11,000 feet above sea level, was ascended by the Administrator, and an exploration of its neighbourhood conducted. As the result of these operations several new birds, &c. were added to science, and fresh accessions to our hitherto limited knowledge of the geography of the region made.

From a geographical standpoint the central and western divisions have yielded a more plentiful harvest during the period over which these remarks extend, than probably any other part of the possession. The extension of our know-

ledge to the culminating peaks of the Owen Stanley Range alone enriches our resources to a far greater extent than any previous or subsequent effort in the field of exploration. Indeed the success of that great undertaking proclaims itself aloud to the world in a boldness of character, so conspicuous that other deeds of heroic character are eclipsed by its brilliancy. With no elaborate or pretentious preparation Sir Wm. MacGregor, with a mere handful of followers, most of whom were unacquainted with the forms of higher civilisation, set out in no statelier a yacht than an ordinary whale-boat for the Vanapa River, where it was thought an easier means of access to interior regions might probably be discovered. Struggling heroically with the rapid current of the Vanapa they succeeded in covering a distance of 40 miles. River transport from this point being no longer possible, the remainder of the upward journey lay over dangerous creeks, almost inaccessible precipices, and rugged mountains. The perils of this hazardous journey are probably unequalled, and certainly unsurpassed in the history of exploration and discovery. It is only to a few—a very few indeed—that the actual conditions under which this expedition laboured are known. Few, indeed, there are who know that in the most difficult positions, and at the most critical moments, when Papuans and Europeans alike were unable to either advance or retreat, Sir William, at the imminent peril of his own life, led the way, forcing formidable obstacles to yield; his actively and skilfully wielded knife cleared the dense brushwood that almost defied penetration. Precipices and rugged inclines were not sufficiently powerful barriers to his powerful will; even positions where his followers were transfixed in amazement were not enough to repel him. He imposed upon himself a task, and he fulfilled it with grace and modesty. From the depôt on the Vanapa to the top of Mount Knutsford the strength of the expedition did not suffer diminution; after this point was reached Sir William was obliged to continue the journey accompanied by only a few coloured followers.

On Mount Knutsford they passed through a region of dense fog, the upper limit of which was marked by a dense growth of slender bamboos. Associated with the continuous dampness of the fog zone was a most luxurious growth of moss, which appeared to insinuate itself into and over everything. The trees it invested with a most dismal aspect, and this was rendered more intensely dismal by the entire absence

of animal life. Not a sound, not a whisper broke the painful silence of the lone surroundings. From the bamboo zone upwards the climate was magnificent, the atmosphere dry and bracing, and the temperature at mid-day in the partial shade of the forest not exceeding 60 deg. or 70 deg. Fahrenheit. The rocky peaks of Mount Knutsford were crowned with an Alpine flora, which also flourished at a lower altitude within the highest zone of the mountain. The clouds of this region were apparently motionless, their upper stratum being like an Arctic landscape of dazzling whiteness. Diorite and crystalline micaceous schist represented the geological character of Knutsford's summit and base. It was noticed that after 10 A.M. the regions below the summit of this mountain were entirely obscured by dense vapour. Before that hour an extensive and magnificent view of the whole southern coastal slopes could be obtained, the sinuosities of the Vanapa could be traced, and the great physical features of the country followed without effort. Advantage was taken of the position by the leader, who executed a topographical sketch of the representative heights. Following along the course of Mount Knutsford, they descended to and crossed the Vanapa at au altitude of 10,130 feet above sea-level. Renewing the ascent of the central spur of the Owen Stanley Range, across the river, they reached Winter's Height, 11,882 feet, from which to the summit of the great range was comparatively but a step. A cypress forest mantled Winter's Height, and the howling of wild dogs was the only sound that broke upon the awful silence of the stupendous Alpine region. From the top of Mount Douglas strawberries were obtained, and the summit of the range disclosed a great variety of grasses, daisies, buttercups, forget-me-nots, and heaths.

On attaining the culminating eminence of the Owen Stanley Range, upon which Sir William bestowed the illustrious name of our gracious Sovereign Queen Victoria, it was discovered that the crown of the mountain was composed of six separate peaks, with a common base. The peaks occupying the extremities were scaled without difficulty, but those of intermediate position, being composed of bare precipitous rocks, were ascended only with very great difficulty; indeed, in the act of climbing one of these the leader of the expedition nearly forfeited his life. In the day-time the atmosphere was clear, dry, and bracing; the nights were cold, and the early morning dawned upon a region white

with frost and jewelled with long icicles. At midday the temperature in the sun was 70 deg. Fahr. on the top of the highest peak. The unique views from the peaks of Mount Victoria were most remarkable,

> "A glorious vision burst upon their sight,
> As on the topmost peak they took their stand,
> To gaze from that clear centre on the world,
> And measure with their proud delighted eyes
> The vast circumference, whose radius stretched
> Seaward and landward, each forty miles.
> Beneath their feet a burnished ocean lay,
> Glittering in sunshine."

Far away, on the one hand, lay the mysterious shores of the north-east coast, and on the other the dotted waters of Torres Straits, with its numerous islands and coral patches, while far to the northward appeared the stupendous heights of Mounts Albert Edward, Scratchley, Parkes, and Gillies, so named by Sir Wm. MacGregor. The rock specimens obtained from this Alpine region pointed to its limited geological character, crystalline micaceous schist being abundantly represented. Formerly geographers had thought that the Owen Stanley Range comprised the whole unbroken mountain chain extending to the south-eastern peninsula, but the observations of this famous expedition demonstrated the existence of the disunion between Mounts Victoria and Obree, which renders the recognition of a distinction between the two mountain masses necessary.

One of the first divisions of the British possession is the St. Joseph District, bordering Hall Sound, and overlooked by the highlands of the Kovio Range and Mount Yule. Watered by a fine stream, the basin of the St. Joseph River is luxuriant in vegetation, rich in soil, and opulent in cultivated products, among which the taro flourishes in great abundance. The district has been extensively explored by Sir William MacGregor, and the conditions of the native inhabitants investigated. At the close of 1890 the Kovis Range and the summit of Mount Yule were successfully explored by the expedition of the Victorian Branch of the Royal Geographical Society of Australasia, commanded by Mr. George Belford, an officer of the New Guinea Government, under whose auspices the expedition was conducted. After personally directing its organisation, His Honour the Administrator accompanied the party for some distance inland in the St. Joseph District, and having conducted the explorers to its base, he left them to accomplish the ascent of

the mountain, which was reached on Christmas Day. Formerly it was thought that Mount Yule held the same relation to the Kovio Range that Mount Victoria does to the great mountain mass bearing the name of Owen Stanley. It appears now, however, that former views require modification, to the extent of recognising this great physical feature as an independent isolated mass shot upwards from the lowlands of the St. Joseph district. This circumstance may be accounted for by the volcanic character of the mountain. The expedition in passing through a schistose country met with traces of gold. The Kovio range is forested to its summit, and on its slopes and outliers numerous native tracks and villages exist. From these and other indications of life it was supposed that the country is occupied by a numerous population. The expedition experienced wet weather, and met with few forms of animal life.

About the end of 1889 Sir William MacGregor commenced the ascent of the Fly River in a steam launch and two whaleboats. In this he was accompanied by a party of 18, including Europeans, Papuans, and other coloured men. The influence of the tide at 150 miles from the river's mouth appeared to altogether cease. After passing through low, swampy, and uninteresting country, the junction of the Fly and the Strickland Rivers was reached; this was named after Captain Everill, who commanded the expedition sent ont by the Royal Geographical Society of Australasia in 1885. Stones aud pebbles of quartz were met with for the first time at 486 miles from the mouth of the river. At a place called Lario Bank, so named after one of the members of the expedition, who received an arrow wound from a party of aggressive natives, good indications of gold were obtained by washing the gravel in a tin dish. Some 523 miles up the Fly long and dangerous rapids were encountered, the river bed was found occupied by sandspits, islands of small stones, pebbles of granite, limestone, conglomerate, quartz, slate, basalt, flint, petrified wood, coral, and shells. In latitude 5deg. 58min. south, some 535 miles from the river's mouth, the limit of steam navigation was reached. From this point the journey was continued in the whaleboat, which was dragged through the rapids by a rope. Two new streams were discovered and named the Palmer and the Black Rivers respectively ,in houour of Sir A. H. Palmer and the Hon. M. H. Black, of Queensland. After traversing some 590 miles of the river, a splendid view of the Victor Emmanuel Range was obtained about from

35 to 40 miles away. In this section of the river traces of gold were also found. The general physical character of the country consisted of low forest-clad sandstone hills, ranging about 300ft. high, the trees being similar in character to those common to the lowlands of the coastal regions. The exposed face of the high banks of the river disclosed a seam of lignite some 6in. in thickness, but of no value for commercial purposes.

As numerous snags rendered further progress by boats impracticable without examination of the river, a fortified camp was constructed on the bank of the Palmer, some 600 miles from the mouth of the Fly River. Here the shade temperature was 90 deg. at mid-day, and 74 deg. Fahr. at night. Traces of fine gold were found here also. Two Polynesians and one Papuan were placed in charge of the 600-mile camp, and the remainder of the party proceeded in the whaleboat some 14 miles further up the Palmer River. From this position the Victor Emmanuel Ranges were again viewed. These ranges, which seemed to lie wholly within the German territory, are apparently excessively rugged and precipitous, part of them, at least, being inaccessible. Between these and the position of the explorers lay a range of mountains of from 5000ft. to 6000ft. high. Part of this, which appeared to lie within the German possession, was named Mount Blucher, and the British section Mount Donaldson. This part of the country appeared to be inhabited by a large population, less nomadic than their southern neighbours. Their large and well cultivated gardens denoted the habits of an agricultural class of people. In view of the scattered position of the expedition, and the fact that a much longer time would be required to explore the ranges than the party could afford to devote to that purpose, it was decided to turn back. Commencing the return journey on the morning of the 24th January, 1890, the scattered fragments of the expedition were collected safely, and the mouth of the river reached after an absence of five weeks and four days, the distance travelled during that time being about 1200 miles. Concerning the results of this expedition, the first to accomplish the remarkable feat of navigating over 600 miles of river in the interior of New Guinea, it may briefly be stated that for administration purposes the information obtained is important. Commercially, however, the results are of less value, especially above Everill Junction. The existence of gold has been clearly established beyond doubt, but we are

not justified in believing that it would be obtainable in payable quantities.

Although thunderstorms were usual after 2 or 3 o'clock in the afternoon, there appeared to be no regular rainy season. The temperature ranged from 85deg. to 90deg. Fahr. during the daytime; at night, however, the thermometer fell to from 72deg. to 76deg. Fahr., a change that Sir William MacGregor could only account for by assuming that colder currents were wafted from the snowy mountains of Dutch New Guinea. The highland regions enjoy comparative immunity from mosquitoes and sandflies. Two cases of sickness per day was the average condition of the health of a party of 19. In all only one of these gave the leader any anxiety. No evidence was obtained of the existence of an interior race distinct from the coastal natives. The dialects of the upper and lower tribes differ entirely. They are agriculturists and live in settled communities on the lower part of the river; in the middle region they are nomadic, owing to the low, swampy condition of the country and the occurrence of floods; the dwellers of the upland zone are apparently fixed cultivators of the soil. Their weapons consist of the bow and arrow. The women clothe themselves with the usual petticoats, and the bodies of the men are tattooed. The most favourable season to explore the Fly basin would be during the months of June and July. It would then be possible to obtain information upon the climate during the south-east monsoons. The birds would then appear in their most gorgeous plumage, and the collections for scientific purposes would in consequence be more valuable. It was a source of very great satisfaction to the leader that during the progress of the expedition the relations maintained with the natives were of the most friendly character, excepting in one instance, in which no reason can be assigned for the hostility offered at Lario Bank.

Concurrently with the Fly River exploration the Administrator extended his examination to the western country, towards the Anglo-Dutch boundary. Part of this region, within the boundary of the Kawa Kussa delta, had formerly been visited by various exploration parties, so that no remarkable new geographical features were discovered by this expedition. Careful examination, however, threw some light upon formerly obscure questions concerning the geography of the numerous water channels abounding in this locality. Advantage was taken of this occasion to examine the hill of Mabuadauan, at the mouth of the Kawa Kussa River. Upon this prominence,

of some 200ft. in height, it was decided to establish a station for the use of the Government Resident Magistrate. The inhabitants of this region live a wretched life of uncertainty and unrest, being constantly terrorised by the Tugeri tribe, who, approaching from the westward, annually fall upon these people and massacre both men, women, and children. It was noticed that the Kiwai Island dialect was understood as far west as the Island of Saibai. No natives, nor signs of human habitation, were met with from the Maikussa delta to within 70 or 80 miles of the Anglo-Dutch boundary, the whole of this vast unoccupied region being chiefly remarkable for its low uninteresting character and extensive mangrove foreshore. While examining the coast line Sir William MacGregor discovered an important river, disemboguing into Heath Bay, in latitude 9deg. 15min. S., longitude 141deg. 30min. E. To this stream the name of Morehead River was given, in honour of the Hon. B. D. Morehead, late Chief Secretary of Queensland. It is a fine watercourse of some 200yds. broad and probably five fathoms in depth at its mouth. The country in the neighbourhood of its lower reaches is swampy and unattractive, being clothed with dense forest, mangroves, and other varieties of vegetation, upon which the eye is constrained to rest in the absence of a brighter landscape. Above this region the river assumes the form of continuous lagoons and swamps, so that no defined banks mark the limit of the stream. These swamps are the haunts of wild pigmy geese, catfish, and crocodiles. Some natives were seen and heard, but all efforts to induce them to hold intercourse with the explorers failed. Their outriggerless canoes, dug out of hard dark wood with stone adzes, measured about 20ft. long. In their gardens, which were neatly cultivated, grew two varieties of sugar-cane and patches of taro. On the higher reaches of the river the natives were somewhat less shy, and after very tedious parleying they were induced to hold brief intercourse with the visitors. Their language being entirely different from that spoken by other known tribes was not understood by the explorers.

When in the neighbourhood of the Anglo-Dutch boundary the expedition was much gratified to meet a camp of representatives of the notorious Tugeri tribe. Physically they are equal to any other known tribe of the Possession, being of singularly robust appearance, with light brown skin and hazel eyes. Their heads, which are prominent and well formed, were adorned by frizzly hair, plaited into long pendants with the lower ends thereof formed into small balls hanging down upon the neck of

the wearer. They pierce the ears and ornament them profusely with large rings of the wire feathers of the cassowary. The septum of the nose is also pierced and likewise ornamented. They encircle the neck with pigtails, parts of the human body, dried and tanned, and strings of wallaby teeth. While lavishly ornamenting themselves in other respects, they exhibited no indications of tattooing or other special skin marks. Their mode of salutation is to touch the navel, an operation which they perform with special grace. Their weapons consist of the bow and arrow, in the use of which they are remarkably dexterous. At first it was intended to adopt such measures as would probably prevent these pirates from undertaking their usual annual journey eastward for man-hunting purposes, but it was unfortunately discovered, to the great disappointment of the leader, that the Tugeri camp was on Dutch territory.

In this district spring tides rise and fall 12ft., one full tide occurring once in every 24 hours. The very low tides occur in the evening, when several miles of foreshore are left dry by the receding waters. The current of the rising tide sets strongly eastward, and that of the fall towards the west. At 9 o'clock the morning calms are replaced by a northerly breeze, which continues till noon, when a strong southerly wind sets in ; after continuing in this direction for several hours it gradually works back again to the northward. Electrical disturbances, associated with heavy precipitation, originating in violent squalls, were of daily occurrence. The recorded minimum and maximum thermometric measurements were 75 deg. and 92 deg. Fahr. in the shade.

Climate.

Concerning the climate of British New Guinea we are not in possession of sufficient data to enable us to write with any degree of authority, nor yet are we able to contribute anything of special use to climatology. Generally speaking it may be said that the possession is healthy, no dangerous epidemics being known, and, excepting occasional attacks of malarial fever, Europeans suffer no greater inconveniences than residents of other tropical climes. In the Alpine zone of the Owen Stanley Range the climate is apparently dry and bracing, and in the basin of the Upper Fly River the temperature during the night time is invigorating and refreshing, mosquitoes and sandflies being less troublesome than in the coastal districts. Speaking of the climate, Sir Wm.

MacGregor says:—"For my part I was always glad of a blanket in the morning; such a covering I could not tolerate at Port Moresby or in the east part of the possession at this time of the year. This makes the Upper Fly River district rather a pleasant abode at this time of the season" (January). In the neighbourhood of the east end of the territory several of the numerous islands enjoy salubrity of climate and freedom from the drawbacks so frequently experienced in low swampy localities. Essentially a tropical climate, British New Guinea possesses a wet and a dry season, the former extending from November to the end of March, during which time heavy thunder storms, accompanied by drenching rain, prevail. While the dry season lasts the south-east trade winds contribute greatly to the comfort of life and to the salubrity of the climate.

Administration.

The affairs of the territory are administered from three principal centres of organisation, Port Moresby being the geographical Centre, Samarai the Eastern Division, and Mabuadauan the Western District. At each of these places a Resident Magistrate is stationed with jurisdiction over a given area.

Religious Organisations.

The organisations devoted to Christianity are—(1) the London Missionary Society, dominating the division extending from East Cape west to the Anglo-Dutch boundary, excepting the St. Joseph's District; (2) the Wesleyans, who occupy the Archipelagos of islands at the south-east end; (3) the Anglicans, whose field of operations extends over the whole north-east coast line; and (4) the Roman Catholics, located on Yule Island, in the St. Joseph's District. Some of these have quite recently established themselves, but there can be no doubt that the influence of their presence on the native mind must be very considerable.

Natives.

A remarkable feature of the native inhabitants of British Papua is the numerous tribal divisions and the almost correspondingly different languages or dialects spoken by them. Even in localities separated by only a few miles the dialects spoken differ the one from the other, in some cases considerably. The Motu, which is the language spoken and taught by the missionaries at Port Moresby, is understood over a considerable area, both east and west of that place; but outside

that neighbourhood changes and variations occur, so that at the head of the Great Papuan Gulf, and in the Fly Basin, the Motu language is a foreign tongue. The same also applies to the eastern end, and to the islands adjacent thereto, where the philological variations are numerous and conflicting. While the people met with in the highland zones of the Owen Stanley Range spoke a dialect akin to that of the coast Papuans, those encountered on the Upper Fly River expressed themselves in a tongue every word of which apparently differed from that spoken by the tribes of the lower regions, and from that spoken by any known coastal community, notwithstanding that the people themselves exhibited no distinctive characteristics of race, the only marked contrast being in lightness of colour. In the western division the same diversification of speech is met with, where neighbouring tribes are unable to hold intercourse one with the other, even if friendly, by reason of incompatibility of language. No doubt this may in some measure be accounted for by local environment, constant civil intertribal war being the means of isolating communities, so that no friendly intercourse is held, by reason of which, together with other attendant causes, an incongruity of language may have unknowingly been established. Of the ethnography of these natives we do not as yet possess sufficient data with which to elucidate that interesting branch of knowledge; its elaboration must therefore be left to future generalisation.

Fauna.

The Papuan fauna is of a fairly representative character; it includes no big game, such as that met with in Africa and India, but its avifauna rivals that of any other part of the world. Of animals, those chiefly to be found in the Papuan land are the wild and domestic pigs and dogs, the tree kangaroos (*Dendrolagus dorianus*), wallabies, cuscus, cats, rats, mice, *(Bita)*, and other representatives of less note. The pigs are animals of great value to the native inhabitants; they are fondled and petted like children, the young being sometimes suckled at the breasts of the women, an abominable practice in itself, and greatly intensified when associated with participating infants. The market value of the pig is occasionally equal to that of a human being. Some of the dogs are almost, if not wholly identical with the Australian dingo; those met with on the Upper Fly River being of a bright orange colour, and some-

what graceful in appearance. Reptiles are represented by a considerable number of different species, the largest of which are those dreaded amphibious monsters of the Saurian family, the alligators, which are plentifully scattered throughout the territory in the numerous rivers, creeks, and swamps, being a constant menace to human life. The snake family is well represented, those met with, however, being chiefly common to Australia, excepting the death adder (*Acanthophis*), and the whip-snake (*Diemansia*). The greater number of reptiles are innocuous. Lizards and frogs also abound in all parts of the possession. Insects are in swarms, from the harmless butterfly to the dreaded scorpion. Of the feathered family Papua can probably produce a more brilliant variety than any other island on the globe. There is the noble cassowary, the large and pigmy geese, ducks, fowls, pigeons, cockatoos, (both black and white), parrots, kingfishers, hornbills, rifle-birds, several varieties of bower-birds, the cat-bird, and probably over 25 different species of the paradise bird.

Geology.

As yet our insight of the geology of British Papua is both elementary and fragmentary. Based upon no specially geological examination, our acquired knowledge is more hypothetical than practical, being derived chiefly from examination of collected specimens, which probably do not fully represent the primary condition of the localities from which they were obtained. Notwithstanding this, it will be freely admitted that many useful and practical data are available upon which a general sketch may be based. Ths first collection of specimens from the Fly River revealed the auriferous character of that part of the territory. Although the analysis was based chiefly upon some stone tomahawks of altered sandstone and greenstone or diorite, the results obtained were indicative of the existence of gold; while the conclusions we are enabled to arrive at inferentially of the probable auriferous character of the high ranges of the interior, are derived from an examination of the fragmentary specimens of slate, quartz, sandstone, greenstone, and jasperoid rocks, obtained from the coast east of Redscar Bay, also from the material adduced by the expedition to the summit of the Owen Stanley Range, upon which occasion indications of gold were actually obtained in the bed of the Vanapa River. Basaltic lavas occur frequently, and palæozoic rocks are met with in abundance. The fossiliferous rocks noticed were those

belonging to the Tertiary period. Of the specimens obtained the first were discovered at Yule Island. Others have since been found in several localities in the Possession, notably the Upper Strickland River, where marine fossils, chiefly mullusca, were discovered ; the occurrence of ammonites, on the middle region of that watercourse was also observed. It is clear however, that in speaking of the palæontology of Papua much care and caution is necessary, and that even the best results obtainable are only of a fragmentary character, to which too great an importance must not be attached. Regarding the goldfields, we are in a position to summarise with some considerable degree of confidence, both as to the localities operated upon and the probable value of the issues of these operations. Although gold-bearing deposits have been obtained in several districts of the Possession, the chief, and practically the only centre of activity is the island of Sud-Est, and in a much lesser degree some of the neighbouring islands, where gold in payable quantities is procured. It is a somewhat remarkable fact that the general geological features of British Papua are in a very considerable degree identical in character with those of Australia, several specimens resembling those of the Silurian series from goldfields in New South Wales, while some of the fossiliferous rocks were obtained from beds of clay similar to those at Geelong and Cape Otway in Victoria. From these foregoing remarks it may not be unreasonable, nor unjustifiable, to assume that mineral areas of great value may yet await discovery by the penetrating eyes of British pluck and enterprise in Papua.

In submitting these brief notes to the Geographical Section of the Association the writer trusts that under the distinguished auspices of its learned Committee, the representatives of kindred organisations, and through them the people, may be induced to aid in furthering the interests of British enterprise in our Papuan possession ; while our peaceful efforts in the cause of science and humanity are directed to the development of its natural resources, and in extending the influence of civilisation to its remotest parts.

The writer, in conclusion, desires to acknowledge his very great obligations to his deeply esteemed friend, Sir Wm. MacGregor, for much valuable information concerning British New Guinea.

5.—VOLCANIC PHENOMENA IN SAMOA IN 1866.

By DR. FRASER, *Sydney.*

THE MSS. of the late Rev. Thos. Powell, who was for many years a missionary in Samoa, contain a contemporary account of the volcanic disturbances there in the year 1866. This account was furnished by Taunga, a native teacher.

1866 : Aug. 25.—There set in this day a continual rain, with a strong southerly wind. This continued till the end of the month.

Sept. 7.—There was a very severe shock of an earthquake, which terrified the people.

Sept. 13.—The sea was swollen up like a rock between Tau and Olosenga, and the waves broke furiously around the spot. The people thought this was caused by fire. At mid-day mud was sent up as from a spring. It was now certain that a volcano was forming. In the afternoon the ebullitions were much more violent, and continued till next day, at intervals of about an hour and a half.

Sept. 14.—They now became more frequent, coming every hour, and increasing so much in frequency that they occurred every four or five minutes.

Sept. 15.—The frequency of the eruptions was now at the rate of 49 in an hour up till noon, after which time they came every half minute, the flame flashing through the clouds of mud, smoke, and stones. The people were much alarmed by this aspect of things. The sea-water got warm; great quantities of fish were seen on the surface, of which many were floated to the shore dead, and among them some unknown monsters and fish of the deep. Men gathered quantities of the fish, and the land stank with them.

Sept. 16 (Sunday).—To-day the eruptions were more violent than ever, and had increased so much in volume and frequency that they were now about ten in a minute, and sent up such quantities of steam and smoke as quite to hide Olosenga from view; the sea broke fearfully all round the island; the smoke rose high and dense; masses of dirt were whitened in the air like floating clouds of slacked lime; all accompanied by a tremendous noise like air rushing from below, and in its contention with the sea sending up clouds of smoke.

Taunga says that he now began to think the group would be rendered uninhabitable; that when the southerly and

easterly winds prevailed Olosenga would be buried, and Tau likewise with northerly and westerly winds.

Sept. 16 to 19.—The frequency and fury of the eruptions continued night and day at much the same rate as before.

Sept. 20 to 22.—The commotions now increased greatly in fury and in dimensions; the volcano became like a great crater, emitting mud and clouds of black, brown, and white smoke. These discharges of mud and large burning bright stones and scoriæ were sufficient, according to Taunga's conjecture, to fill more than 50,000 men-of-war. Quantities of scoriæ floated on the sea, and were washed ashore along the opposite coast of Ofu. These discharges were thrown up higher than the mountain of Olosenga. One volley of rocks and stones succeeded another so rapidly that the masses ascending met those descending in mid-air, thereby causing a hideous concussion and roaring noise. The din was heard at Tutuila* as though close at hand. The eruptions were seen from there.

Sept. 23 (Sunday).—The violence of the volcanic storm had now subsided, the eruptions occurring only about once in every two hours. This much surprised the people, who did not expect so sudden a change. The clouds of black and brown smoke were much higher and spread more widely; then they suddenly disappeared altogether, and only the swell of the sea remained.

Sept. 25.—The commotion began anew, with increased frequency and violence.

Taunga's estimate of the dimensions of the volcano is this:—It was one hundred feet wide and about half a mile long, or a mile, perhaps, from north to south. It was much nearer to Olosenga than to Tau, about two miles from Tau.

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* The nearest point of the island of Tutuila is sixty nautical miles from the scene of the eruption, between the islands of Tau and Olosenga.

6.—THE INFLUENCE OF SPANISH AND PORTUGUESE DISCOVERIES DURING THE FIRST TWENTY YEARS OF THE SIXTEENTH CENTURY ON THE THEORY OF AN ANTIPODAL SOUTHERN CONTINENT.

By JAMES R. M'CLYMONT, M.A.

THE possibility of an antipodal continent follows from the sphericity of the earth, which has been generally admitted by geographers since the time of Aristotle. The older theory of the Hellenic Greeks regarded the earth as a disc surrounded by Ocean and floating in the midst of the heavens. All the seas had outlets into the ocean. In the east the river Phasis united the Euxine with the ocean, in the west the strait of the Columns of Hercules similarly connected the Mediterranean with it. The diameter of the earth was of twenty days' journey. The true successors of this Homeric school were the monastic illuminators of the middle ages. Their Imagines Mundi represent the earth as a wheel, the tire of which is the Homeric Ocean. It has three spokes, one of which is placed perpendicularly to the other two; the horizontal spokes represent the waters which were supposed to divide Europe and Africa from Asia, namely, the Tanais or River Don, the Black Sea, the Hellespont, the easternmost portion of the Mediterranean, and the Nile; the perpendicular spoke represents the remaining portion of the Mediterranean dividing Europe from Africa. The east, as the realm of Paradise, is placed at the summit of the wheel; Jerusalem is the nave, for "operatus es salutem in medio terrae" (Ps. 74, 12). The antipodal continent finds no place in the typical Imago Mundi, or, if alluded to at all, it is only to dismiss it as a fable: "Extra tres autem partes orbis pars trans oceanum ulterior est qui solis ardore incognita nobis est cuius finibus antipodes fabuloso inhabitare produntur." (*Orbis e codice taurinensi. Mappemonde dans un MS. qui contient un commentaire de l'Apocalypse.*) Atlas de Santarem.

The first terrestrial globe, so far as we know, was constructed about 150 B.C. by Crates of Mallus. Crates divided the globe into four land segments, one of which represented all of the earth known to the ancients. The other three were conjectural. They were divided in one direction by an equatorial ocean, in the other by an ocean

extending round the globe through the poles. The idea of Crates thus approaches the reality, with the exception of the equatorial ocean. It was perhaps based on the same supposed necessity of an equal distribution of land and water in order to maintain the equilibrium of the globe which influenced Mercator to postulate the existence of an antipodal continent. The device of Crates survives in the orb which forms one of the symbols of royalty at the coronation of our sovereigns.

Another element in the conception of a *Terra Australis* was added by Marinus of Tyre and Ptolemy of Alexandria. Eratosthenes (226 B.C.) had made the eastern coast of the African continent terminate in about 12° N. at the Land of Cinnamon, whence it was supposed oriental spices were brought. Hipparchus (160 B.C.) prolonged the coast indefinitely towards the south. But Marinus (about 100 A.D.), perhaps basing his representation on misunderstood reports of Greek travellers, diverted the African coast towards the east at about 15° 30′ S., and produced it to about the longitude of the Golden Chersonese, at which point he made it trend northwards to meet an extension of Asia, trending southwards immediately beyond the Magnus Sinus, or Gulf of Siam. The Indian Ocean thus became an inland sea. This scheme was not upset until the true form of Africa had been discovered, and even after that time it survived in many sixteenth-century maps in the eastern and isolated position which they gave to Zanzibar.

The theory of Marinus was adopted by Ptolemy (about 151 A.D.), whose great weight as an astronomer gave authority to all he promulgated. His astronomy, *ἡ σύνταξις μέγιστη*, was translated into Arabic in the caliphate of Mamun, 813–833, and was familiar to the Arabs under the name Almagest (*al μέγιστη*). But their geographical science owes more to an anonymous work supposed to date from the eighth century and to be of Greek origin, supplemented by information supplied by the Arabs themselves. This is the *Rasm al arsi*, or description of the earth. We have not sufficient data to enable us to judge whether the author of this work accepted the Greek or the Ptolemæan scheme of the southern hemisphere. Later Arab geographers combined the two. The Tabula Rotunda in the Oxford MS. of Edrisi (1154) shows a round earth encircled by the Homeric Ocean and with the Ptolemæan extension of Africa; but the Indian Ocean is not surrounded by land, being connected with the

outer Ocean towards the east at the fabulous country Uak-Uak, beyond the longitude of the Malay Peninsula.

The voyages of Marco Polo, 1268–1295, and the enterprises conducted under the patronage of Prince Henry of Portugal, 1418–1460, caused a revival of interest in the study of geography. The Geographia of Ptolemy was translated into Latin by Jacobo Angelo de Scarparia in 1409, and printed in 1475 at Vicenza, and in 1478 at Rome with illustrative maps designed by a certain Agathodaimon, who is said to have lived in the fifth century. From the time of its dissemination, from 1307 onwards, the Book of Marco Polo, dictated by that traveller when a prisoner in Genoa, had been the great work of reference on oriental geography as well as the favourite *thesaurus* of travel and adventure. It was originally edited in a somewhat barbarous French, by Rusticien de Pise, and from that edition, or from a revised version of it in purer French, several MS. translations were made into Italian and Latin in the course of the fourteenth century, and the work became widely known in the sixteenth century from the versions of Grynæus (1532) and Ramusio (1556). The earliest cartographer who shows marks of Polo's influence is Martin Behaim (1492), and thenceforward Polo's travels, with more or less understanding of their author, enter into the composition of the world-maps of the sixteenth century.

Polo, in his account of Java and Sumatra, adopts a phraseology of ancient date. Ptolemy applied the name Ἰαβαδιου to three islands. The term is a Greek form of the Sanskrit "Yavadvipa" or Isle of Barley, which is found in ancient inscriptions in the island of Java. The name may have passed through Arabic into Greek, and been conveyed by Greek travellers to Europe. The Sanskrit name of Sumatra was Prathama Yava, or the First Java, in allusion perhaps to its proximity to Asia. (*Jour. R. Asiat. Soc.*, Bombay, 1861, App. lxviii.) The Arab geographers also recognised more than one Java, and Ibn Batúta mentions one island "Jâwah" and another "Mul-Jáwah," or, "the original Java." As he calls the capital of a Mahometan State in the former island "Somothra," it is probable that his Jâwah was the island now called Sumatra, and his Mul-Jáwah our modern Java. Polo describes one of the kingdoms of Javva la méneur under the name "Samara," but the name Sumatra as applied to the entire island does not appear on any European map with which I am acquainted

until the year 1459, when Fra Mauro so denominates it on his Mappa Mundi. Fra Mauro's two Giavas, Giava maggiore and Giava menore, lie to the east of Asia, and the former seems to be identical with Cimpangu, or Japan.

In Polo's and in Varthema's times Java was regarded as an island of much greater extent than it really is. Marco Polo was informed that it was the largest island in the world, and gives its circumference as five thousand miles (*Le Livre de Marc Pol*, ed. Panthier, cap. clxii.), and that of Javva la méneur as two thousand. The companions of Varthema wished him to go and see "the largest island in the world," and having called at Bornei they took their way to the island called Giava. (Varthema, ed. Hakl. Soc., pp. 247–8.) In later times Java Minor was regarded as an island distinct both from Java and Sumatra. Thus Pigafetta (1522) says that at half a league from Java Major is the island of Bali, called also Java Minor. Another writer, Manoel Godinho de Heredia, who cites Polo, Varthema, Battista Agnese (1550?) and Petrus Plaucius (1598), places Java Minor in a new position altogether. Having described Sumatra, and Java under the name of Java Maior, and previously to describing Borneo, he mentions a Java Menor, and under that name describes the Javva la méneur of Polo. But his Java Menor is not in the position of Polo's Javva la méneur, but is in the Mar Austral in 24° S. lat. Its people possess many spices never seen in Europe, and are so ferocious that the inhabitants of the neighbouring islands hold no intercourse with them. (*Informaçao verdadeira da aurea Chersoneso*, Lisboa, 1807, p. 116.) The 163rd chapter of the Book of Marco Polo commences with the words "Quant on se part de Javva et on nage vii. c. milles contre midi adonc treuve l'en deux isles, l'une grant, et l'autre meneur. L'une a nom Sandur et l'autre Condur." Commentators until recently were unable to identify these islands, as well as the countries of Locach and Maliur and the island of Pontain and other places, the position of which depended on the direction to be taken from Java to Sandur and Condur. At last Marsden solved the difficulty by pointing out that if "Cyamba" were read in place of "Javva" and the southerly course for 700 miles were followed from Cyamba, Condur or Pulo Condor would fall into its right position, Sandur would correspond with the Two Brothers, Locach with Lo-Kok, an ancient name for the lower part of the modern Siam, Pontain with Bintang, and Maliur with

the Land of the Malays—the Malay Peninsula. But this emendation had not been thought of in the time of Mercator, who, in his desire to record all known discoveries, placed Sandur and Condur, Locach and Maliur where the MSS. of Marco Polo's travels indicated them, namely, to the south of Java, on or near a northern extension of the *Terra Australis*. Java Major on Mercator's map of the world of 1569 correctly represents the modern Java; Java Minor is an imaginary island situated in a gulf of the *Terra Australis*.

The next influence on the development of the conception of a *Terra Australis* was that exercised by the oceanic discoveries of the Spanish and Portuguese in South America in the end of the fifteenth and beginning of the sixteenth centuries. The necessity of discovering ocean routes to the east was the outcome of the aggressive attitude of the Turks and of the internecine rivalry of the maritime republics of Italy. As early as 1285 Genoa had sent out an expedition under the leadership of Tedisio Doria and Ugolino di Vivaldo for the purpose of discovering a path to the Indies by way of the south of Africa. The expedition never returned.

For nearly two centuries the more enterprising amongst the European nations of that period, by means of treaties with the Turks or of alliances with the Mongols, attempted to retain an interest in oriental trade. By the former means the Genoese retained their depôts in the Crimea for merchandise coming from the east by the overland route through Turkestan, and the French and Venetians came to an understanding with the Sultan of Egypt regarding the navigation of the Red Sea. Syria, under the power of the Crusaders, had become another mart for the oriental productions which came by the way of the Euphrates Valley, and the Venetians occupied a quarter in Ptolemais, and the Pisans one in Antioch, whilst the Genoese had counting-houses in Jerusalem, Joppa, and Cæsarea.

The inability of the European nations to support the Crusaders in their conquest necessitated the withdrawal of those merchants from Syria. The Genoese were compelled to retire in 1474 from the Crimea, whilst the Venetians so jealously conserved their rights in the route by the Red Sea that other maritime nations had either to fall back upon the Genoese attempt of 1285, or strike out some entirely new enterprise in order to reach the east. The Portuguese did the former, and reached the east by the Cape of Good Hope

in 1497, after a long series of fruitless efforts. The Spaniards did the latter, and in the attempt chanced to fall in with America on the way. The vast extension which Marco Polo's travels had given to Asia towards the east helped to implant in the mind of Columbus the idea of reaching it by sailing to the west, and the new world of Columbus was never more to him than the easternmost portion of the old. The subsequent discoveries of the Spaniards and Portuguese altered many of the Ptolemæan ideas about the configuration of the southern hemisphere. It was now seen that there was no eastward extension of the African continent; the Indian Ocean was not a *mare clausum;* Asia did not unite with an extended Africa; Ceylon was not of equal extent with the Indian Peninsula; Taprobana was removed from Ceylon to Sumatra; Catigara from the imaginary Southern Asia to Cape Comorin, and thence to unexplored Southern America.

Columbus and Bartholomew Diaz were the precursors of a host of Spanish and Portuguese discoverers. These nations were strong enough to keep the other maritime powers in check, and France in the early part of the sixteenth century had to content herself with stealthy expeditions undertaken by private individuals or syndicates, whilst England shortly began to play the part of the bold buccaneer. All charts and sailing directions were carefully conserved, and only general descriptive narratives were allowed to circulate outside of Spain or Portugal. "Manuel, King of Portugal," says Lelewel, "in his letter of 29th July, 1501, informed Ferdinand of the discovery of Brazil by Cabral, but he secreted all the nautical charts; they were deposited in the record office of the Admiralty, and could not be removed from the kingdom. All publicity was given to the glory and renown of the state and its navigators. Narratives of the voyages were scattered abroad in *brochures* and fly-leaves. People found in these the adventures of the travellers and everything that could astonish their minds, but they could find nothing there that would enable them to determine geographical positions with certainty. Charts were drawn which gave a picture of the discoveries, but they were destitute of every indication which could instruct mariners regarding the dangers or the direction of the voyages." (*Geographie du Moyen Age*, ii., pp. 141–142.) The same remarks hold good of the policy of Spain, and only a few original records of her discoveries give details

which could assist the curious to follow in the tracks of the discoverers.

Of such the best known instance is the account of the voyages of Vespucci. Two of these performed in the service of Spain and two in the service of Portugal were narrated by that voyager in a letter written, as appears from internal evidence, to Pier Soderini, the Gonfaloniere of Florence, and printed without a date, but probably in Florence in 1505. This epistle received widespread attention through being translated into Latin as an appendix to the popular *Cosmographiæ Introductio*, St. Dié, 1507. Humboldt and Varnhagen have done much to elucidate these voyages of Vespucci, and to restore the honour justly due to his name, but even they have been misled by their anxiety to identify too closely the landfalls and terminal points of his voyages, and have in several cases altered his plain statements of the latitudes observed. It is not to be wondered at, then, that the Spanish alguazil and author Enciso, writing in 1519 about a voyage performed in the service of Portugal, should have misunderstood its scope. Enciso is not reliable in matters beyond his personal cognisance, as Varnhagen has pointed out. (*Vespuce et son premier Voyage*, Paris, 1858, p. 25.) The former speaks thus vaguely of a discovery of land in 42° S.: "This Cape of Good Hope has to the west the land called austral; from the Cape of Good Hope to the "tierra austral" the distance is 450 leagues; it is in 42°; it is 600 leagues from Cape St. Augustine; it is S.E. $\frac{1}{4}$ S. from Cape St. Augustine. Nothing is known of this land except what has been seen from ships, for no one has landed on it." (*Suma de Geographia*, Seville, 1519, fol. liv., verso.) Mercator, quoting this passage of Enciso, places a *Promontorium Terræ Australis* on his *Magna Orbis Descriptio*, 1569, in 42° S. and about 15° of Boavista, and this cape cape came to be regarded by some geographers as an unassailably correct position. Jean Paulmier thus speaks of it in his *Mémoires touchant l'Establissement d'une Mission chrestienne*, p. 9. I think there can be little doubt that Enciso had heard but an imperfect account of Vespucci's third voyage performed in the service of Portugal, and that he misplaced the land seen from the ships on the 7th of April, 1502, and generally identified with the island of South Georgia. (*Lettera*, p. 28.) The mistake might have arisen through misunderstanding Vespucci's statement that he coasted 600 leagues from Cape St. Augustine, and in sup-

posing that that distance was to be taken in a direct line; which, adding 600 leagues to 8°—the latitude of C. St. Augustine—would have brought the ships to about 42° S. Further, Enciso or his informant seems to have supposed that at this point was the land which was sighted from the ships. Desbrosses somewhat more accurately says: "The Austral coast discovered by Amerigo Vespucci is to be found marked on the maps nearly at the intersection of the 52nd parallel with the first meridian." (*Histoire*, i., p. 100.) The map of Vaugondy, however, published in the work of Desbrosses, adheres to the older indication of Enciso, and places the *Cap des Terres Australes* in 42° S. The error of Enciso is of interest as the earliest transference of an actual discovery from its proper position to the coast of the legendary *Terra Australis.*

The next instance of a similar kind occurs in the *Novus Orbis*, published in Basle in the year 1532. That work contains a Latin translation of a letter from Lorenzo Cretico, Ambassador of the Venetian Republic at the Court of Portugal, beginning with the words "Serenissime Princeps," and addressed probably to the Doge. It is dated June 27, 1501, but seems not to have been published until 1507, when it appears in the *Paesi nouamente retrouati.* The letter gives an account of the expedition of Cabral to Calicut, in which Brazil was discovered on the 22nd of April 1500, and a passage in it is to the effect that the ships discovered a new country on their way, and lying to the south-west, before reaching the Cape of Good Hope,—"di sopra dal capo d Boâsperâza uerso garbi hano scopto una terra noua la chiamâo d li Papaga." Further, that they called it the Land of Parrots, because these birds there exceeded a cubit and a half in length, and were of various colours; that the writer had seen two of them; the sailors believed that this coast was that of a continent, because they sailed along it for two thousand miles without reaching the end of it; it was inhabited by naked and well-made men. The translator of this letter for the *Novus Orbis* has rendered "uerso garbi" by "lebegio vecti vento," making it to appear that Cabral was driven on this new coast by a south-west wind; and Oronce Finé, whose map of the world of 1531 accompanies the Basle edition of the *Novus Orbis*, 1532, places a *Brasielie Regio* as part of the *Terra Australis*, reaching nearly to the tropic of Capricorn, whilst more to the east is a *Regio Patalis*, a word supposed by Santarem to be derived from the

Sanskrit, and to mean the nether region. The occurrence of the inscription "Mare magellanicum" on Finé's map shows that he was in part influenced by the voyage of Magellan in his delineation of the *Terra Australis*. Mercator followed the incorrect indication given in the *Novus Orbis*, and charted the *Psittacorum Regio* in about 42° S., and with a longitudinal extension from 30° to 70° E. of Bonavista. This tract bears the inscription "Psittacorum Regio sic a Lusitanis hûc libegio vento appulsis cum Callicutum peterent appellata propter earum avium multitudinem. Porro cum hujus terræ littus ad 2000 miliarum prosequuti essent necdum tamen finem invenerunt inde Australem continentem attigisse indubitatum est."

It was probably due in the main to the personal character and ambition of Charles VIII. and Louis XII. that France expended her energies so exclusively in feudal wars at the period of the great oceanic discoveries. With the accession of Francis I. and the regency of Louisa of Savoy commences an awakening of interest in these discoveries, which eventually resulted in active participation. In 1516 the *Paesi nouamente retrouati* appeared in a French translation. In 1523 or 1524 Pigafetta presented to the Regent a copy of his book, that namely which described the voyage of Magellan, and a French abridgment of the work by Jacques Fabre appeared shortly afterwards at the Regent's request. In 1532 Peter Martyr's first three decades were abridged and published in French, with a dedication to Charles Duc d'Angoulême, a son of Francis I.; and abridgments of the fourth decade and of the second and third letter of Cortes were dedicated to another child of Francis I., the Princess Marguerite (the Colines Receuil.) At this time there existed schools of hydrography at Dieppe and Arques, which were patronised by the royal family. A member of the latter school, Pierre Desceliers, executed a map of the world in 1546 at the order of Henry II., which is reproduced in the Atlas of Jomard, No. XXI. The same hydrographer produced another mappemonde, bearing the arms of France and Dauphiny, and supposed to be of earlier date than the last-named. It is preserved in the British Museum, and catalogued Add. MS. 5413. This chart is sometimes called the Dauphin Map, at other times, from its having belonged to Edward Harley, Earl of Oxford, the Harleyan Map, and as the map of 1546 is also known as the Dauphin Map, the other designation is probably the better of the two.

Desceliers and his fellow-hydrographers appear to have had access to some of the pictorial charts of the Spaniards or Portuguese to which Lelewel alludes. An extensive portion of their southern hemisphere is occupied by hydrographic outlines of a continent which in some instances is represented as united with the *Terra Australis*, in others is made separate from it, and to which the name Jave la Grande or Java Maior is applied. Its northern outlines are in part co-terminous with those of Java, in part with those of other islands of the Malayan Archipelago. This appears from the names with which that portion of the coast is studded. But on closer examination one finds that the entire outlines of Java, of certain Malaysian islands, and of Java Major, correspond with the outlines of Central and South America from the Gulf of Honduras to about 23° S. or, in some of the maps (Desceliers, 1550, Desliens, 1566) to the vicinity of La Plata. In order to rectify the bearing of the coast-lines it is necessary to invert them, which can be simply done by placing the chart before a mirror. The inverted outlines should be compared with an early map of America, such as that of Juan de la Cosa. There are indeed some striking points of resemblance between these charts and the map of De la Cosa. De la Cosa represents two large islands and some small ones off Cape St. Augustine; the French charts have one large island and some small ones in the same position. These islands may represent the discovery of Cabral, who at first regarded Monte Pascoal as part of an island. (*Geo. du Moyen Age*, ii., p. 110.) Another point of resemblance is in the delineation of the mouths of the Tocantins and Amazon and the island Marajo. In both cases that island is represented as a peninsula between two gulfs, and the two coast-lines at this point are strikingly similar. Again, in De la Cosa's map the river which disembogues a little to the south of Cape St. Roque is produced so as almost to cut off the north-eastern corner of Brazil; in most of the French maps it cuts it off completely.

I will now point out some details which I think will be held sufficient to establish the identity between Jave la Grande and the American coasts I have mentioned. The bay marked "Baye Perdue" has to the N.W. of it a small island marked "Ye de S. Xtofer," or Island of St. Christopher (commonly known as St. Kitts), and the bay itself corresponds with the description given by Vespucci of "a

very fine port, which was formed by a large island that was situated at the mouth, inside of which there was a bay, very deeply indented" (*Lettera*, p. 18; in this bay he anchored in his second voyage, in the summer of 1499. The description applies either to the Gulf of Paria or to the mouth of the Orinoco; and that Baye Perdue is intended for one of these places is evident from its position relatively to St. Kitts. If "Perdue" is a translation of the Spanish "Perdita," the name may have been given it after the loss of two of the ships of Vincente Pinzon in that neighbourhood in the year 1500. The islands off the coast to the west of Baye Perdue represent very fairly the Leeward Islands, and one might without difficulty pick out Margarita, Tortuga, and Curaçoa; whilst some of the headlands are probably represented as islands. The Gulf of Venezuela is not drawn as such, but, at the place where we should expect to find it, are several islands representing the peninsulas of Paraguana and La Guajira. We may conclude that the pilot who drew the original chart (like the pilot who drew the original charts from which the *Hydrographia* of 1513 was constructed) sailed past the entrance of this gulf without detecting it. Another West Indian island serves as an index to this part of the coast, under the name "Ye de Lucayos." This name appears on De la Cosa's map in the singular, "Lucayo," apparently as the equivalent of Guanahani, and it is elsewhere used in the plural of the Bahamas generally. The coast then trends S.W. into the Gulf of Darien; and on this part appears on the chart of Desliens the word "forillons," an adaptation of the Spanish "farallones," or reefs above water. The "Farallones" of the Gulf of Darien are referred to by Galvano (Hakluyt Soc. Ed., p. 99), who speaks of them as being sighted by Rodrigo Bastidas in his voyage of the year 1503, but mentions them as if well known prior to that time.

At the extremity of the Gulf of Darien the coast-line of the MS. charts ceases to correspond with the actual coast. The explanation, I think, is to be found in supposing that the navigator who drew the chart left the coast at this point, crossed the mouth of the Mosquito Gulf, and resumed his hydrographical labours where he again sighted the coast—that of Nicaragua,—some distance to the south of C. Gracias a Dios. At this point another of the West Indian Islands assists our identification. N.N.E. from the promontory which we have supposed to be C. Gracias a Dios—

"C. da fremosa" on the Harleyan Map—lies the island of Jamaica, "Ysla Samaqua" or "Jamaqua." Its true position would be N.E., but it is accurately enough placed relatively to "C. da fremosa" to indicate that the cape is C. Gracias a Dios and not P. Manzanilla nor C. Catoche, the only other capes with which one might attempt to identify it. As for the spelling of Jamaica, that varies much in old maps and treatises. The *Hydrographia* has "Jamaiqua," Galvano writes it "Zamayca." From this point the orientation is entirely false, for the coast, instead of being produced nearly due west, slopes off to the S.W. and produces the impression of a coast-line accurately enough depicted as to hydrographical features, but so depicted by a mariner without a compass.

Let us now return to the point whence we started, and proceed southwards. South of the N.E. corner of the map is a river with the much-abbreviated legend, "R. de St. Po;" perhaps San Pedro, for in the *Mappemonde peinte par ordre de Henri II.*, it is translated St. Pierre; its position accords with that of the Rio San Francisco. Then we have an unnamed bay, and the outlet of a river marked "R. Grande," answering to Bahia dos Todos Santos and the R. Paraguaçu or "great water," of which Rio Grande might be a translation. Desceliers delineates a channel from this bay to the mouth of the Tocantins, and thus converts the N.E. corner of South America into an island. No such separation, however, occurs on the Mappemonde of Desliens, which is otherwise similar to the Harleyan Map; perhaps Desceliers has taken a liberty with his original, in order to reconcile his idea of the identity of the north-western portion of the chart with the island of Java, a circumstance to which I shall again refer. The next bay, marked "Baye bresill," is probably the "porto seguro" of Cabral. The name Brazil, which is stated to have been bestowed by French sailors, was very soon adopted by the Portuguese, for we find a "Rio Brazil" in the *Hydrographia* in a position coinciding with this "Baye bresill." The undue extension given to the harbours of this coast is a noticeable feature; and although one might reasonably expect that the ports in which ships anchored would be shown more in detail than places which were merely sailed past, I think this consideration alone is hardly sufficient to account for the exaggeration, but that this southern portion is the work of a less skilled draughtsman than the northern—of one who had

not sufficient knowledge of cartography to reduce his plans of the harbours to their proper relative proportions on a chart of the entire coast.

The indications for the guidance of mariners which occur at various points of the coast sufficiently attest the hydrographic character of the original charts; and the illustrations are an evident addition of the copyist, and are as characteristic of the systematic mediæval map of the world as the nautical information is characteristic of the pilot's chart. Amongst these nautical indications are "Terre enneguade," submerged land (Desceliers, 1546); "ap quieta," perhaps, a sheltered place (*Idem*); "Roches," rocks, (1546, 1550); "Arenes," sands, (1550); "Ansses," coves, (1546). One can only guess at the meaning of some of the inscriptions to the south of "Baye bresill." "B. de gao" may be a corruption of "agoada," watering-place; "C. de St. drao" of "Cabo do san padrâo" (Harleyan Map), Cape of the Holy Cross. The last, if such be the interpretation of it, either marks the spot where a Padrâo was set up, or is the vulgarisation of the "Caput Sancte Crucis" of the *Hydrographia* and the map of Ruysch—a general rather than a specific appellation, coinciding with the name of the country, Terra Sanctae Crucis. The next noticeable name is that of the deep harbour marked "Hame" or "Havre des Yles," for so I conceive we must read "Hame de Sylla," the copyist converting the words "de las Ylhas" into "de Sylla." Probably the legend "ye de Saill" is a corruption of the same sort. This harbour of islands corresponds to Rio de Janeiro, a little to the south of which the coast-line in the Harleyan Map ceases to present any distinct geographical features. On a map of 1550, however, the features are still depicted, and the last to be observed is the "Baye des Rivieres," in the position of Rio Grande or Sao Piedro do Sul.

An acquaintance with these charts of America was not confined to the French school of cartography, for the same outlines are to be found in a map by Cornelis de Jode, entitled *Hemispheriū ab aequinoctiali linea ad circulū poli ātarctici*, published in his *Speculum Orbis*, Antwerp, 1593. De Jode's adaptation differs in several striking particulars from that of the French. The adapted American outlines of De Jode occupy a similar position in his scheme of the globe to the same outlines in the scheme of the Dieppe school. They bear the name *Ter. australis incognita.* There is no dividing strait corresponding to that which divides

Jave la Grande from Java; Java maior is in its proper place as the island of Java; the other islands of the Archipelago which the French school unites with Jave la Grande are not so united by De Jode, but are located elsewhere; and the eastern coast is produced further to the south than in any of the French MS. charts, and terminates with the inscription "Estrecho de Magellanes." The most remarkable difference, however, is that De Jode's outlines are not inverted, but are turned round an angle of 45°, so that the north coast of South America becomes the west coast of the *Ter. australis incognita.* Moreover, the country is not hydrographically outlined, but is delineated so as to harmonise with the continental character of the atlas. Its name and description are engraved on the so-called *Ter. australis incognita,* as follows:—"Maxima et admiranda insula occidentalis America, nunc quarta pars orbis nominata: ditissima fertilissimaq; omniū rerū ad vitā necessariarū. Veteribus philosophis, cosmographis, et potentissimis Monarchis ignota et primū imperante Carolo V. perlustrata. In his peninsulis et isthmo, sunt maxime temporū et rerū variationes: quoniā subiacent incoli 4 zonis, una frigida est, altera torrida, tertia et quarta temperata." I think we find in this inscription a confirmation of the opinion, tenable on other grounds, that the original charts were Spanish, as the Portuguese receive no share of the honour of the discovery of America. The legend bears internal evidence of the influence of Johann Schoener, who, in his *Luculentissima quaedā terrae totius descriptio* (Norimbergae, 1515), describes the New World under the name "America," and speaks of it as "quarta orbis pars," and "insula mirae magnitudinis"—an opinion which he subsequently renounced in favour of the theory that America was united to Asia, citing, strangely enough, the discoveries of Magellan as a proof:—"Modo vero per novissimas navigationes factas anno 1519, per Magellanum versus Moluccas insulas in supremo oriente positas eam terram invenerunt continentem superioris Indiae quae pars est Asiae." (*Opusculum Geographicum,* Norimbergae, 1533, ii., 1 and 20.)

The "America" of De Jode bears few inscriptions, but some of them are significant; such as "R. S. Augustin," nearly in the position of the cape of that name, and corresponding to the Rio S. Augustino of the *Hydrographia*; and in the extreme south, "Estrecho de Magellanes." This record of Magellan's voyage proves that the original of

this map of De Jode was compiled not earlier than 1522, and the facts just mentioned regarding the opinions of Schoener seem to indicate a German, perhaps Schoener himself, as its compositor. An account of Magellan's voyage reduced from Pigafetta's relation to the Emperor was sent by Maximilian of Transylvania to Cardinal Lang, Archbishop of Salzburg, then attending the Reichstag in Nürnberg, in November, 1522; and the map or maps from which the one we are considering was derived may have accompanied and illustrated Maximilian's letter, and been handed over to Schoener for his inspection and use.

In his address, "Inspectori" (1569), Mercator tells us that for the purpose of delineating with exactitude the various countries, he compared the nautical charts of the Spaniards and Portuguese one with another, and also with most of the printed and manuscript accounts of the voyages. Ortelius acted as collector of materials, Mercator as elaborator, and the former in his travels through the Netherlands, Germany, Italy, and Great Britain, probably procured the charts to which Mercator refers, including those used in his construction of the *Terra Australis.* Gerard de Jode, the father of Cornelis, worked at one time in company with Ortelius, and may have had access to his collection, for there was an excellent understanding between the various members of the Antwerp school. It is not so easy to conjecture how the Spanish charts passed into the possession of French cartographers: certainly in a different manner, since they appear in so different a guise. When Pigafetta visited France after his return from the circumnavigation of the globe, Giovanni Vespucci, nephew of Amerigo, held the position of Piloto-Maior, and as such would be custodian of the original charts. He seems to have been lax in his duties, for he is said to have published a map of America in 1524, for which action he was dismissed from office. Further, he inherited all his uncle's charts and papers. From him Pigafetta may have improperly obtained copies of American charts, and conveyed them with him to France. Maximilianus Transylvanus may have done the same, and sent copies to the Cardinal Archbishop of Salzburg. The coasts delineated in the Harleyan Map correspond very closely with the coasts visited by Vespucci in his second and third voyages, but we have adduced reasons for believing that the southern portion, at least, was the work of a less skilled hydrographer than Vespucci. Not a few pilots were employed, first by the

Portuguese, then by the Spaniards, or *vice versâ*, and some of them even returned from their second masters to their first: this greatly complicates the problem of the nationality of the original explorer.

I have noted one or two points of resemblance between the French MS. charts and that of Juan de la Cosa; and that pilot may have been the author of the northern portion of the chart, from the vicinity of Cape St. Roque westwards. The West Indian Islands included in the chart may have been touched at in the outward or homeward voyage of the hydrographer, and were well known to Juan de la Cosa from his connection with Columbus. In Alonzo d'Hojeda's voyage with De la Cosa as his pilot, from May, 1499 to June, 1500, the ship of the commander was wrecked, and d'Hojeda reached San Domingo in a small boat on the 5th September, 1499. As the outward voyage from Cadiz to the American coast only occupied 42 days, it is possible that d'Hojeda may have reached the Bay of Honduras, been there wrecked, and afterwards reached San Domingo, all between 27th June and 5th September. If the portion of the chart in question does emanate from De la Cosa the shipwreck (and probable loss of compass) might account for the inaccuracy in the direction given to the coast of Honduras.

The illustrations with which the Dauphin and the other MS. maps are enriched are an addition of the colourist; for such illustrations are never present in simple hydrographic charts. Moreover the illustrations in some of them, as in that of Desceliers of 1550, do not in all cases refer to the countries where they occur, but to quite other parts of the world. It is very doubtful whether the illustrations were copied from original drawings at all; those of Desceliers (1550), for example, are mere figments of the artist's brain based upon the tales of travellers. Such are the group of dog-headed beings representing the inhabitants of Angania or the Andaman Islands, according with the account of Marco Polo (ed. Panthier, cap. clxvii.); whilst the group of sun and ox worshippers represents the cults ascribed to the Javanese by Varthema (Travels, Hakluyt Soc., 1863, pp. 251–2). The illustrations of the Harleyan Map are sufficiently real to be based upon the descriptions by Vespucci and Pigafetta of what they saw in Central and South America. Vespucci mentions pigs and deer amongst the

animals he saw in his first voyage (*Lettera delle isole*, p. 14); the natives are said to be naked and to deprive their bodies of all hair except that on the head; they carried bows and arrows, clubs and spears, hardened in the fire (p. 5); they had their meat in earthen basins or in the halves of pumpkins (p. 6), which are represented in two places on the Jave la Grande of the Harleyan Map; their houses were made like huts or cabins (capanne) of very large trees covered with palm-leaves, and in some places of so great length and breadth that in one single house dwelt six hundred persons (p. 7). In the second voyage, Vespucci observed on the island supposed to be Margarita, that the inhabitants dwelt underneath arbours, which protected them from the sun but not from the rain (p. 21)—a rude shelter such as is depicted on the Harleyan Map, which also represents the palm-trees. In his description of the country and inhabitants of Verzin or Brazil, Pigafetta accords with Vespucci in certain particulars. They have pigs which have their navel on the back (*Voyage of Magellan*, Hakluyt Soc., p. 46); the men wear no beard, because they pluck it out (p. 45); their dwellings are long houses, in each of which there dwells a hundred persons (p. 44). The Patagonians who were encountered in Port S. Julian had low huts or tents made of the skins of the guanaco and removed their huts from place to place. These huts may be intended by the conical structures of Desceliers. The object most characteristic of South America is the guanaco, for such seems to be intended by the camel-like animal that appears on some of these maps. As drawn by Desceliers in 1550 it is very much of a monster, and might well have been conceived after the description of Pigafetta:—"This beast has the head and ears of the size of a mule, and the neck and body of the fashion of a camel, the legs of a deer and the tail like that of a horse, and it neighs like a horse." (*Voyage of Magellan*, p. 50.) And further on Piggafetta relates that the natives tamed this animal and led it with a cord, as we find represented by Desceliers. The juxtaposition of these South American subjects with the outlines of South America may be fortuitous. Jave la Grande offered ample scope for the purpose of illustrations, and may have been merely selected as a convenient blank space in which to place them, their appropriate position being more or less conjectural. At the same time our suggestion about Piga-

fetta's possible share in the dissemination of these charts is upheld by the agreement between his written descriptions and the illuminations on the Harleyan Map.

The date of the mappemonde of Jean Cossin, 1570, overlaps that of Gerardus Mercator's *Nova et aucta terrae descriptio*, the engraving of which was finished in August, 1569. The distinguishing feature in this map was the new projection devised by the engraver, which develops the degrees of latitude in a ratio proportional with the increase in the degrees of longitude. Mercator himself said that his projection lacked mathematical justification, but that it was the only method by which the sphere could be reduced to a plane projection, and that it would be convenient for navigators. The navigators, however, were slow to avail themselves of new and untried methods, and despised a map which displayed coasts that were unknown to them, and which subordinated nautical details to a theoretical *tout ensemble*. Mercator had very clear and definite views on the subject of a southern continent. His biographer, Gualterus Gymniis, says that he divided the world into three continents, one of which consisted of Asia, Africa, and Europe, the other was India Nova or Occidentalis, or America, and of the third, although he was not ignorant of the fact that it was still unknown, yet he affirmed that he could demonstrate the existence by solid reasons, and that it was not inferior to the other two in size and weight, for, if it were, the globe could not remain stable with respect to its equilibrium. (*Gymniis, Vita Mercatoris.*) If we turn to the map of 1569 for the representation of this theory, (traceable also in his world-map of 1538) we find the whole Southern Ocean awanting and its place approximately occupied by a southern continent. Beginning from the Terra del Fuego, which is made a part of it, the *Terra Australis* extends in a north-westerly direction towards New Guinea, with which it forms a strait, then trends S.W., W., and N., so forming a gulf in which lie the islands of Java Minor and Petan, followed by a promontory inscribed with the names Maletur, Lucach, and Beach, a corrupted form of Lucach. I have explained how these names, occurring in the Book of Marco Polo, were erroneously placed to the south of Java. But the promontary on which they occur, the adjacent gulf to the east of it, and the coast-line thence to the Straits of Magellan, show another influence—the same influence that produced the Java Maior of the Dieppe school of hydrography. To the west

of the northern promontory is another gulf. Then follows the *Terra Psittacorum*, lying nearly due east and west in about 44° S.; then the *Promontorium Terræ Australis* of Enciso in 42° S. and 15° E. from Boavista. From this cape the coast-line trends southwards to rejoin the Terra del Fuego.

An element unknown to the French cartographers occurs in this conception, namely, Tierra del Fuego, and its conjunction with the *Terra Australis.* There was an old theory that a strait divided the continent of South America and connected the Atlantic and Pacific Oceans, and when De Solis discovered the mouth of La Plata it was believed that he had discovered the entrance to this strait. (Pigafetta, *Voyage of Magellan*, p. 48.) The same theory is upheld by Schoener on his globe of 1520, in which the strait is placed in about 45° S., and is made to divide the *Terra Nova* from another continent named *Brasilia Inferior.* The Genoese pilot who recounts the voyage tells us that Magellan successively entered the Rio de la Plata and the Bay of St. Matthias, in the expectation of finding an entrance to the strait. And when the strait was actually found, it was assumed that the land which lay to the south of it was a part of the *Terra Australis.* An inscription on a map entitled *Brasilia et Peruvia* in the *Speculum Orbis* shows how confused were the ideas of geographers on the subject of the *Terra Australis;* it runs:—"Chaesdia seu Australis Terra quam nautarum vulgus Tierra di Fuego vocant alii Psittacorum Terram." This error was not removed until Drake, in his voyage round the world, was driven to fully 57° S. in September, 1578, when he found that the two oceans united, and that islands only lay to the south of Magellan's Strait. The assumed continuity of the Tierra del Fuego with the *Terra Australis* would induce the ascription of the discovery of the latter to Magellan. This was done by Mercator, Ortelius, and others, for they inscribe on their *Terra Australis* the words:—"Hanc continentem australem nonulli Magellanicam regionem ab ejus inventore nuncupant."

The Terra del Fuego of Mercator and Ortelius is perhaps a misplaced portion of the mainland of America. At least there is a coincidence of nomenclature suggestive of some such misplacement. A Cabo Deseado, correctly placed at the western entrance of the straits, is also to be found on the *Hydrographie Portugaise* near the Gulf of Paria; Golfo di

San Sebastiano has a synonym in the name Porto de San Sebastiano applied to Rio de Janeiro by Diego Ribero (1527) and the author of the *Hydrographie.*

Let me recapitulate. The *Terra Australis* of Mercator consists of the following elements :—

(1.) The outline from about 130° E. of Boavista to Cabo di bon Signale in 290° E. This portion includes Nova Guinea, corresponds with the *Ter. australis incognita* of Cornelis de Jode, and contains the Jave la Grande of the French MS. charts. It is based upon charts of America from the Gulf of Honduras to the Straits of Magellan.

(2.) The outline from C. di bon Signale to Ysole do Cressalina and Golfo di San Sebastiano; possibly another misplaced portion of the American continent.

(3.) The outline from Golfo di San Sebastiano to the Promontorium Terræ Australis; in part purely conjectural, in part representing Vespucci's discovery of land beyond 52° S.

(4.) The outline from the *Promontorium Terrae Australis* to the point of commencement; in part representing Cabral's discovery of Brazil under the name *Terra Psittacorum,* in part purely conjectural.

The results of the whole investigation may be thus summarised :—The theory of an antipodal continent arose as a consequence of a belief in the sphericity of the earth. It was strengthened by the conceptions of Marinus and Ptolemy regarding the configuration of the African continent, and in this aspect held a place in the system of the Arabs. After a long lapse of time, during which geography was not a science but a body of dogmas, and the possibility of antipodeans was scouted, the theory was revived amongst European geographers, in consequence of the new discoveries of the 16th century; and these were erroneously located in a position analogous to that previously assigned to the antipodal continent. This is to be first observed on maps ascribed to Leonardo da Vinci about 1514, on a mappemonde by La Salle, in *La Salade nouvellement imprimée,* 1522, and, with evident reference to American discovery, in the Mappemonde of Finé, 1531. Mercator finally formulates the theory in 1569, having previously indicated his opinions in his map of the world of 1538 in the words placed on the Antarctic continent to the south of Magellan's Straits :—"Terras huc esse certum est, sed quantas quibusq; limitibus finitas incertum." The theory thus pro-

pounded receives sanction from many quarters, especially from the Memorials of De Quiros and of Jean Paulmier.

Here I must close this investigation for the present. If any proof were required of the complete absence of all connection between the theory of a *Terra Australis* and the geographical fact of the Australian continent, it would surely be found herein—that the belief in the former persisted for a hundred years after Australia was visited and mapped by Dutch navigators. And yet to this day a confusion exists between these distinct phenomena, which blurs the outlines of early Australian history. That history may be compared to the history of three streams which have their source in an unknown and half mythical country. There is the stream of Portuguese ascendancy in the East. That stream undergoes changes beginning in the end of the sixteenth century, and from being Portuguese becomes first Spanish then Dutch. Then there is the stream of Spanish conquest passing through Spanish America. A Cortes saw it flow, unwitting whither it went, a De Quiros sailed over its waters, but they bore him to no certain haven. Lastly, there was the French stream, romantic in its origin and flow, its waters liberated at the touch of a native of the mythical land, disclosed to the world's view by his descendant after three generations of silence and only disappearing late in time on the borderland of English enterprise and colonisation. To trace the course of these parent streams, and to discriminate them from their tributary waters is the task of the man who would map out the various origins of the history of Australia.

7.—DISPATCHES FROM THE ELDER EXPLORING EXPEDITION.

By HON. D. MURRAY.

8.—LIFE AND WORK OF SIR JOHN FRANKLIN.

By A. C. MACDONALD, F.R.G.S.

Section F.

ECONOMIC AND SOCIAL SCIENCE AND STATISTICS.

PRESIDENT OF THE SECTION:

R. TEECE, F.I.A.

1.—INTERNATIONAL STATISTICAL COMPARISONS.

By ROBERT GIFFEN, C.B., LL.D.

An old jest runs to the effect that there are three degrees of comparison among liars. There are liars, there are outrageous liars, and there are scientific experts. This has lately been adapted to throw dirt upon statistics. There are three degrees of comparison, it is said, in lying. There are lies, there are outrageous lies, and there are statistics. Statisticians can afford to laugh at and profit by jests at their expense. There is so much knowledge which is unattainable except by statistics, especially the knowledge of the condition and growth of communities in the mass, that even if the blunders in using statistics were greater and more frequent than they are, the study would still be indispensable. But just because we can afford to laugh at such jests we should be ready to turn them to account, and it is not difficult to discover one of the principal occasions for the jest I have quoted, and profit by the lesson.

Statistics are easily mishandled, for the simple reason, amongst others, that people like short cuts, and they are apt to take different figures and compare them with each other, because the things represented by them are called by the same names, without any consideration of the question how the figures are obtained, and whether the things compared are throughout of a like kind. Thus two states will be compared with each other as regards their revenue for Imperial purposes, without any consideration of the fact that in the one certain expenses of government are borne on the Imperial budget, which in the other are borne on the local budget, or perhaps left to private agency; or without any consideration of such a fact as the inclusion in the one budget of loans or the proceeds of the sales of public property as revenue, which in the other are excluded altogether, or specially dealt with. The statistics, however, are not lies in themselves; it is only in the handling of them that the lying takes place. I have thought it would be of interest, therefore, in a meeting like this, to raise explicitly for discussion some of the principal dangers in the handling of statistics to

which the inexpert, and some of us perhaps who think we are expert, are exposed, through the too ready comparison with each other of figures which apparently are applied to facts of a like kind, but which really cover dissimilar facts. Such a discussion becomes more and more indispensable, I think, on account of one of the most important causes of the increased diffusion of statistical knowledge in recent years—the extensive development of statistical abstracts, hand-books, year-books, manuals, dictionaries, statistical atlases, and such like works of reference. Accustomed to see quantities, which are really dissimilar in kind, placed together under the same heading, which is done primarily for the mere purpose of reference, we come to neglect the dissimilarity in our speech, and, by and by, in thought. The numbers of different communities are compared as if numbers alone were something in themselves, without any thought of the different qualities of the units: production, imports and exports, and money wages in different communities are spoken of as if they in all cases meant the same things, and without any preliminary discussion of what the figures really do mean. All this is essentially mischievous, and is contrary to the most elementary lessons in the study of statistics. It is the part of the student to re-act against the temptation to which he is exposed to use works which are only good for reference in this haphazard fashion.

POPULATION STATISTICS.

At the risk of being common-place through enforcing considerations which no one will dispute, I propose to begin with the foundation statistics of all—those of population. It is obvious at the first sight, when the statement is made, that for very few purposes can the populations of different countries be placed together as if the units were the same. The peoples of Europe and the United States are as a rule units of a very different value from the units of population in Hindoo, Chinese, negro, and aboriginal communities. Even among European peoples themselves there are enormous differences.

It follows, then, that many questions of first importance for which statistics of population are used, cannot be discussed at all without reference to the quality of the units. The fact has only to be stated to be admitted. Among such questions, for instance, is the question of the area that a given population will support. The plain of Bengal, say, supports some seventy million Hindoos—the population, in numbers, of the United States. But if the consuming power of the Hindoo were at all like that of the average man of the United States, how many could Bengal support? The same, *mutatis mutandis*, comparing even a French or German with a United States population. The units in the different cases are entirely different. The area of the United States might suffice with the same total value of production that it now has for the support of perhaps twice as many French or German as it could support of people of the actual type of those now planted on the soil of the United States. The question may be turned about another way. Along with the increased capacity of

consumption there may, or may not, be an increased capacity of production. If there is such an increase of the capacity of production, or even a greater proportionate increase than there is of consumption, it might well be that on the area of Bengal there could be planted an even larger population than there now is, yet with the average consuming power of the people of the United States, and not merely the average consuming power of the Hindoo. So greatly different may be the varying units of population which we are so ready to speak of as alike.

Among other questions of the same kind is that of the strength of different populations for war and industry. The differences between peoples are really almost infinite, and are not always coincident as regards war and industry. The Hindoo population, for instance, appears to be differentiated from a European race in respect of fighting force to a much greater extent than it is differentiated in respect of industrial force. The Chinese population, on the other hand, though it is weaker at present than European populations in fighting power, as well as industrial power, is, perhaps not so much differentiated as the Hindoo is, and presents altogether a more difficult problem for their possible or probable antagonists. Negro populations, again, are differentiated in a different way, having a capacity for great exertion in some directions, but not in others. Such differences among peoples are so obvious that no one will dispute them when stated.

Even if units of population were generally alike instead of varying greatly, and in all sorts of directions, another question arises with reference to frequent comparisons of population and areas. The number of inhabitants per square mile is often quoted as denoting conditions adverse or the reverse to the populations concerned. But of course there are areas and areas, originally and as modified by the qualities of the people dwelling upon them. In order to make a comparison of the number of inhabitants per square mile of any practical value at all, the nature of the areas, and of the qualities of the inhabitants, must be studied, and the facts must also be adapted to the discussion of particular questions, such as the relation of area to conditions of health, and the like. To say, for instance, that Belgium has so many inhabitants to the square mile, and France so many fewer, does not mean anything, because the size of the communities compared is entirely different, and in point of fact there may be areas included in France more thickly peopled than Belgium. It is the same in the comparison of a European country with the United States. The conditions are entirely different; while not a few of the comparisons so readily made would be upset by the consideration that one third of the area of the United States, excluding Alaska, is desert, and is, properly speaking, not inhabitable at all. A similar remark would also apply to the countries of Australasia treated as a unit. The facts are all useful enough for reference; that is not disputed; but the moment they come to be discussed the nature of the quantities must be studied, and strict attention given to the point of the comparison attempted.

Connected with this last is another question of the same kind.

What is the area which really supports a given population? If people on a given spot are able to carry on industries which enable them to buy from the rest of the world what they want, are they supported by that area, or are they not? In a sense they are supported, for they live by the industries which they carry on there. In another sense they are not, because they are not self-contained. Foreign trade is the breath of their life. But this description is applicable not merely to countries like the United Kingdom, which manufacture largely, and carry goods largely for all the world. It is equally applicable to a country like the United States, which exports food, raw cotton, and other raw materials, wherewith to buy the things of which it stands in need; or to countries like Australasia, which export wool, the precious metals and other metals, to an extent without example in history.

All these considerations are so obvious that I have to apologise for introducing them. No one, it will be urged, can make the blunder of overlooking them. But in point of fact, and this is my justification, the grossest blunders are constantly made. We know for instance, in regard to the question of the population which a given area will support, that nothing is so common in books of travel or geographies, with reference to unoccupied or partially occupied areas, than statements that a given area will support so many million inhabitants. Nothing is said as to what kind of inhabitants. But clearly the sort of inhabitants will make all the difference. The idea of boundlessness of area so common in new countries, and which is to some extent an illusion, if I may venture the remark, is also due to neglect of the fact of quality of population. The area of a given country in a sense may be practically boundless, but it may be equally true that the full occupation of the country would imply a continual re-adaptation of the people to new economic conditions—that there is by no means boundless room for the same sort of people carrying on the same sort of industries. To the same effect, the idea of narrowness, of area so common in old countries, where there is constant wonder as to what is to be done with the growing population, is based largely on the vague assumption that there must be some proportion between area and population, whereas, as we have seen, and as experience proves, populations of indefinite magnitude may be supported on narrow territory. Every city is an illustration in disproof of the supposed connection between population and area in the sense stated. Area is no doubt necessary to a wholly self-contained people, if such a people can be conceived of, short of one which occupies the whole habitable territory of the globe; but as no nation is self-contained there is equally no means of settling *a priori* the maximum limit of inhabitants per square mile which a community may occupy; and that a nation reaches a high maximum is no proof of its being in an unfavourable economic condition, or the reverse.

Other illustrations may be given of an underlying confusion of thought in these matters, which occasionally comes to the surface. I have seen, for instance, at home an attempt made to show that the English Empire is more aggressive than that

of Russia, because in a given period it has annexed a larger area and a larger population than Russia had done, the truth being that the area annexed by either country in the period in question was largely desert, so that it hardly counted one way or the other and that the populations annexed were of most various quality. The point of real aggressiveness or not was studiously overlooked in this ingenious statistical comparison. Constantly at home, also, there are continual discussions on the balance of power, in which the numbers of the populations and the armies they can put in the field are simply counted ; whereas the whole question turns largely upon the quality of the respective populations and the state of their warlike preparations, and not so much upon mere numbers. The question of quality of population arises in a different way in those political questions which are settled by numbers at the ballot-box in democratic communities, and I am not sure but that some of the underlying assumptions of politics are based on the refusal to recognise the essential differences of different peoples, as, for instance, in the concession at home to the people of Ireland of an equality of voting power and representation in the Imperial Parliament, and, really, far more than an equality, whereas, in some qualities, such as wealth, they cannot be regarded as equal, although they may be equal, or superior, in yet other qualities. Common-place, therefore, as it seems, to say that when we see columns of comparative figures of population we must not assume the units to be alike, the applications of the doctrine are not really common-place. We are all subject to the influence of unexpressed and underlying assumptions, and I have only given a few out of many possible illustrations of the dangers that may arise in using these very ordinary figures without constantly thinking of what they mean.

I come finally to less debateable ground in one way, but where there is practical mischief from the misuse of figures. Nothing is more common than to compare populations which may be assumed to be racially very nearly alike, or approximating in certain qualities, but which really differ greatly from each other in regard to the distribution of the population according to age. France and Germany, for instance, are continually spoken of as if the difference of their numbers made a corresponding difference in their force. In fact, the population of Germany contains a much larger percentage of children than that of France does, and the numbers of adults in the two countries do not differ so much in proportion as their total numbers do.

To show what differences there may be in the relative proportions according to ages in different communities, I have brought together certain figures extracted from the last census, in each case showing the total numbers, the total male population, the males above the age of 20, and the males between 20 and 40, in France, Germany, and the United Kingdom, respectively. (See Table A annexed.) From this it will be seen that France, with a population of close on 38 millions, has 11,828,000 males above 20 ; and Germany, with a population of just under 47 millions inhabitants, or upwards of 20 per cent. more than that of

France, has 12,435,000 males above the age of 20, or only 5 per cent. more of this class of the population than France has. The proportion of males above 20 in the one case is 31 per cent. and in the other 26½ per cent. only. In the United Kingdom, where the total numbers by the last census available for me in preparing this paper, are less than in either France or Germany, the proportion of males above 20 to the total population is 25½ per cent. only. On the other hand, the number of males between 20 and 40 is proportioned more equally in each case to the total numbers of the population, being about a seventh. Consequently France, although it has a male total population approximating to that of Germany, in spite of its smaller numbers, has only 5,376,000 males between 20 and 40, as compared with 6,577,000 in Germany; while the United Kingdom, with its smaller population than France, had in 1881 very nearly the French numbers of males between 20 and 40. No doubt in 1891 the figures would show a still greater superiority on the part of Germany to France in this particular, while the United Kingdom would be nearly on an equality, but without the very latest figures these are good enough for illustration. France has undoubtedly a much greater mass of old lives to support in proportion to its population than either Germany or the United Kingdom. As they all have, however, the same proportion of males between 20 and 40, it follows that in Germany and the United Kingdom there is a much heavier burden of children than in France. These are material differences in the constitution of the respective populations. At present the burden on the vigorous in each case is much the same, though heaviest, perhaps, in the case of France, as the old lives may be assumed to be more costly than the young, but natural growth must inevitably make an enormous difference in a few generations. Every ten years Germany and the United Kingdom, with the same proportion of non-effectives to support that France has add greatly to their total numbers, and increase their preponderance over France in numbers alone.

The point is not without interest in comparisons between young and old countries. There are many comparisons in which, owing to the different composition of the population in a new country from what it is in an old country, the apparent superiority of the new country is to be explained, not by any superior quality, but by the mere fact that there is a less percentage of the people at ages above 40, and a larger percentage in the prime of life than there is in an old country. For this reason in part there may be less mortality, less sickness, and larger consumption of certain necessaries and luxuries in a new country than there is in an old country measured *per head.* But so far as this explanation holds, there is no superiority in the race of the new country over the old. As far as rates of mortality are concerned statisticians in Australasia are familiar with the fact, and quote rates not upon the actual population, but upon a standard population in which the totals are redistributed according to age, but the correction is required in many other directions as well.

Although also statisticians are usually correct when they deal

with such figures, the point is not without practical importance. I have seen arguments at home, for instance, in which the attempt has been made to prove the superiority of Australians to the people of the United Kingdom in respect of health by means of statistics of the general rate of mortality among the two populations, no account being taken of the different distribution of the populations according to age. The comparisons I have in my mind failed on another point, being based upon a hypothesis as to the connection between mortality rates and the sickness of a population which had not been proved to be true generally ; but even if the hypothesis had been generally true, the neglect of the point of distribution according to age made it entirely misleading.

MORTALITY STATISTICS.

I pass on to other statistics. Reference has already been made to mortality statistics in connection with the special point of the constitution of populations according to age, but there are many other traps in using such statistics for a comparison between nations. The mere question of how the deaths are recorded, and along with that the births, as far as many inferences from the mortality statistics are concerned, here becomes important. Before the statistics of two countries can be compared there must be a certainty that the registration process as to numbers is effective and complete in each. This is not the case in all countries, and it is an especially important matter in historical investigations even in the same country ; the registration of births and deaths in England for instance being notoriously deficient until a comparatively modern period. Even a great country like the United States is still most deficient in this vital particular ; there is no such thing as a good birth and death rate for that great country. In Philadelphia some years ago a local report of the registrar of births, deaths, and marriages was put into my hands from which it appeared that the deaths exceeded the births. I learnt on inquiry that the explanation of a fact which would have been somewhat startling if true was simply the neglect of the laws or administration in the matter of the registration of births. I do not know whether there has been improvement since in this particular city of the United States, but that there is still a lack of a uniform and effective system of registration throughout the country is most certain. It is necessary then to reiterate again and again the necessity for the utmost caution in the use of such common figures as birth and death rates. Always when a writer would make a comparison, let him see that his facts are really the same. He must not be content to take them from a dictionary without inquiring.

These remarks hold good of other comparisons sometimes made, particularly the prevalence of certain kinds of disease. I need not say to an audience of experts what difficulties arise in the definition of disease, and how doctors, apart from mistakes as to what the disease really is of which a man dies, may honestly vary in their statement of the fact from the number

of causes themselves, one doctor giving a proximate and another an ultimate cause. Before statistical comparisons can be made, something must be ascertained as to whether definitions and method of registration are substantially the same in the two countries compared. In historical investigations, even in the same country, the precaution is equally indispensable.

STATISTICS AS TO CHARACTER OF POPULATION.

I proceed next to statistics, from which inferences are commonly drawn as to the qualities of a population - I mean statistics on such subjects as education, crime, sexual morality, drunkenness, insolvency, and thrift. On all these points different countries have statistics, which may have a meaning when they are properly used, but which it is most difficult to use properly.

To begin with education. Which is the most fortunate population of the world as regards the general education of the people? One often hears of the United States in this connection—of the numbers of children of school age and the numbers attending school as compared with less fortunate populations. But let me take the following passage from a memorandum by Mr. Fitch, one of Her Majesty's chief inspectors of training colleges, on the working of the Free School system in the United States, France, and Belgium :—

"In England and Wales the calculations of average attendance are made on the assumption that every school is open at least 400 times or 200 days in the year. It is on this basis that the annual returns in the official report of the Education Department state the average attendance of scholars in infant schools and departments to be 68 per cent., and that in schools for older children to be 82·2 per cent. But in the United States there is no uniform or generally accepted rule respecting the length of the school year. In the principal cities, especially in the East and West, the schools are open 10 months out of 12, and in these the statistics of attendance may be fairly compared with our own. But taking the country through, the average number of days in which the public schools are open is 129 in the year, and this fact implies that in the country places, especially in the South Atlantic and South Central States, the number of school days falls much below that average. In Alabama and in Georgia the schools are open only three months in the year, the teachers are paid by the month, and hold no permanent appointment. In Louisiana and Missouri the small sum appropriated to education by the State barely suffices to keep the schools at work more than four months in the year. In Nebraska the returns for 5,407 schools show 3,904 to be kept open for six months and upwards, 529 for more than four but less than six months, and 974 for less than four months. In New Hampshire the average length of the school term is 22·9 weeks ; in North Carolina it is 12 weeks ; in South Carolina, $3\frac{1}{2}$ months. In Texas the towns give an average of eight months and the country districts five months. On the other hand, in some of the Atlantic States the rate is much higher. In Pennsylvania, exclusive of Philadelphia, in which

the school year includes 10 months, the average is 7·17 months; in Rhode Island, 9 months 11 days; and in New Jersey, 9 months 10 days. It is manifest, therefore, that the figures representing the regularity of attendance require material correction and reduction before they can be properly compared with the statistics of European countries in which schools are, as a rule, kept open during nearly the whole of every year."

From this it is quite clear that one has the greatest difficulty in discussing such a question as the education of a people. You can hardly get to know to what extent children of school age are attending schools of some kind. There are other difficulties behind, as the report from which I have quoted shows, such as the difference of surroundings in which children find themselves when they leave school, the United States, from the general vigour and energy of the whole population, being much more favourable to the development of general intelligence and mental cultivation among its people than countries which may be more fortunate as regards primary school education. There is also such a difficulty as the kind and character of secondary education, and the extent to which it is diffused. Simple at first sight as the problem seems, then, there is nothing more difficult than to compare some countries with each other as regards the degree of their education.

The second subject I have named in this connection is crime, and in thinking of it I confess I have had in mind certain comparisons which have been made in England by visitors returned from Australia to the disadvantage of Australia. There is twice the crime in Australian colonies per head of population, we have been told, that there is in England. But, as we all know who have to handle statistics, there are few statistics so difficult to handle as those of crime. A distinction has to be made between mere police and administrative offences, which vary largely according to the things which Legislatures in their wisdom subject to fine or not, and the more serious offences, such as robbery and murder, which are what we think of when we talk of crime. But in hardly any two countries that I know of is the distinction drawn on exactly the same lines. You are almost never quite sure, therefore, what you are doing, unless you are specially careful, when you compare two countries as regards crime. Further, even if the distinctions were much the same, another difference is made by the police. You may have fewer trials and convictions in one country than in another, simply because the police for various reasons is less efficient, not because there is less crime. When comparisons, therefore, are made between the criminal statistics of two countries without attention to vital considerations like these to show that the subject has been really studied, it is safe to dismiss them without further thought.

But admitting that exact comparisons can be made, that statistics of crime in two countries are reduced to common denominators, I should like to point out that the logic of using them as indicative in any way of the general superiority of one population over another may be at fault. So far as can be judged, the so-called crime statistics of a country are not necessarily significant very much of the general quality of a

population, but they may be significant only of the existence of a criminal element, which is like a disease from which a community suffers, but a disease of a superficial, and not of a vital, character. One population may thus have more crime in it than another, even much more crime, but substantially the two peoples may be almost alike, the extent of the criminality in both being quite immaterial. Say, for instance, that the criminal population by which almost all the crime is done in one country is 1 in 500, or 1-5th of 1 per cent., and in another population it is 1 in 250, or 2-5ths of 1 per cent., is not the criminal element in either so small as to tell you nothing of the general constitution of the people? Not only, therefore, must criminal statistics be used with care as far as the mere data are concerned, but the difficulty of using them as indicative of the general qualities of a population is overwhelming. They can only be used, if used at all, in conjunction with much other information and statistics.

The statistics bearing on sexual morality are equally difficult to handle. The test here that is most commonly used is that of illegitimacy; but the truth is that illegitimacy by itself tells little, for the simple reason that in a town community there may be prostitution without illegitimate births, whereas in a rural community there may be even less profligacy than in the town, but with a larger number of illegitimate births, in consequence of there being no prostitution. In one country also the births may be registered as legitimate, through the children being born in wedlock; but this may go along with a general laxity of morals of a remarkable kind. Sexual immorality is also like crime itself, even when it can be measured on the same basis in two different communities, more or less a thing apart, and it may or may not be significant of the general *morale* of the population. I suppose it is true, for instance, that the rural population of Ireland stands better, as far as statistics of illegitimacy are concerned, than that of Scotland, but it would be a rash inference that in general *morale* the rural population of Ireland is superior to the Scotch. For certain purposes the statistics are good enough, but they must not be pushed to conclusions they do not bear.

Statistics as to drunkenness also require a good deal of careful handling. In fact, I see no way myself of establishing statistically that one population is more or less drunken than another. Apart from the difficulty already referred to, arising from the different distribution of two populations according to age, so that one population has proportionately more adults than another, and consequently has a larger proportion of convictions for drunkenness and a larger proportionate consumption of alcoholic liquors,—the two tests usually applied in such comparisons,—it has to be considered that the tests themselves are not very good. The convictions for drunkenness, it is plain, like convictions for crime generally, may be very largely a matter of definition and of police administration. Before comparisons can be made the state of legislation and of police administration in the countries compared must be considered. As regards the consumption of

alcoholic liquors again, I have never seen any statistics satisfactorily connecting a relatively large consumption of alcoholic liquors with drunkenness. On the contrary the consumption in every community is probably at all times much more largely the consumption of sober people than that of people who drink to excess, and you may have much drunkenness among a people who, like the Americans, are generally total abstainers, and little among a people like the populations of the Southern States of Europe, who are generally moderate drinkers. Thus the question of drunkenness, or the reverse, in a population is not to be easily treated by statistics.

The statistics of bankruptcy or insolvency again are often quoted as a test of the comparative excellence of commercial communities. Here again I have had in my mind some recent comparisons at home between certain of the Australian colonies and England as regards insolvency. These colonies, we have been told, have twice as many failures per head of population as England, or some such proportion. But the traps in dealing with bankruptcy statistics are innumerable. Even in England it is not easy to compare one period with another, owing to difference of legislation making the conditions and record of official insolvency different at one time from what they are at another. The law at one time makes whitewashing so easy that debtors readily avail themselves of the courts to make themselves officially insolvent, and so you have a large number of bankruptcies in the official statistics. At another time the law is so stringent that debtors evade the courts, while creditors do not make them bankrupt because it is not worth while to do so, and so the official bankruptcies diminish. At one time also non-traders may be made bankrupt, at another time they may not be ; and so the record varies. Unless, therefore, the whole basis of the bankruptcy law in each case is studied, no comparison is possible either between period and period in the same country or between different countries. Further difficulties would arise in any comparison owing to the length of the commercial cycle, which renders it most dangerous to take the figures of one year only or even of two or three years for comparison. We can imagine, then, what wild work is made by amateurs when they compare the insolvency of Australia and England. Apart from these differences there are others which are due to fundamental differences of economic condition. I believe, for instance, that in England a larger proportion of the business done is carried on by Joint Stock Companies than is the case in Australia. This may or may not be the case. But, supposing it to be the case, how can the failures of England be compared at all with those of Australia, without taking account of the liquidations of Joint Stock Companies, and to how many units of individual failures is that of a Joint Stock Company to be considered equal ? I would not go so far as to say that no useful comparison could be drawn from existing data by those who go carefully into the subject and study all the conditions. What I am contending for is, that it is utterly impossible for writers in a hurry to make anything of the first figures that come to

hand, and assume that the official record of failures in one country at one time means the same thing as the official record of failures in a totally different country at the same or another time.

Here, too, I would also demur to the test of bankruptcy itself as indicative of the general commercial character of a people, even if figures for comparison could be correctly ascertained. More bankruptcy in the one case than in the other may simply mean greater enterprise making more opportunity for failure, and not an excess of dishonesty in the one compared with another. It may also mean that the industries carried on in the one country, and which are suitable to be carried on in it, are essentially more fluctuating at a given period than the different industries of another country. Farming is often the most fluctuating of all industries. A country dependent on farming may suffer more from bankruptcy at a given date than a country less dependent. In turn, a manufacturing or commercial country may suffer more from catastrophies like war or invasion than an agricultural country would suffer. Perhaps even these difficulties could be overcome or evaded, and bankruptcy statistics be handled so as to indicate differences of character between two peoples; but the labour of the comparison would be very considerable indeed if anything is to be made of it at all.

I come finally to the last branch of statistics referred to as being often used to compare the character of two peoples, viz., the statistics of thrift or the diffusion of property among the masses. Here the temptation is to take some one form of saving, such as savings banks, or the holding of land, or investment in Government stocks, and roughly judge one people by their habits as to this one form of saving. So far as I have observed, the usual comparisons in detail, even as to the one branch of saving selected for comparison, are most erroneous. Thus, I have seen the number of separate inscriptions of French *Rentes* in the books of the French Ministry of Finance treated as the number of separate holders. The truth is that the question of the number of inscriptions of *rentes*, the inscriptions being anonymous, is purely a formal matter, depending upon the sub-divisions which are most convenient for dealing. One individual may, and as a rule does, hold many inscriptions. When the French issued new loans in 1871 and 1872 to pay the war indemnity to Germany, and in subsequent years to re-equip their army and extend their railways, the number of inscriptions in the books of the Ministry of Finance enormously increased, but it did not follow that the number of separate holders of French *rentes* increased in the same degree, or even increased at all. The same with the holding of land. A broad distinction has to be drawn between the number of separate occupiers and the number of separate occupations, the latter (as in Ireland) being often far more numerous than the former. But admitting that the figures as to one branch only can be got hold of, it is plain that unless saving habits in all directions can be compared, no useful comparison can be made at all. What is done by friendly societies, building societies, insurance companies and the like, must all be taken into account, as well as the savings banks, which are most often quoted, or the

holdings of the Government debt, or the holdings of land, which are the favourite investments of the masses of some countries. But I do not know of any comparison of the kind in which these conditions are complied with. French peasants and working classes are often assumed to be much more saving than the corresponding classes of England, but the statistical proof seems to be wanting, and I am not sure that if the accumulations of English unions, friendly societies, and co-operative societies, were properly taken account of, as well as Savings Banks, holdings of Government debt, and investments in land, that the English working classes would come so very badly out of the comparison. At any rate, the comparison is more difficult than is often thought.

Even if comparisons could be made there would remain the question of the comparison of character. A working population which feeds and clothes itself well and makes itself in all ways efficient, provided it saves enough for security, may really be making more of life than a population which starves itself in the present through fear that it may starve in the future. The proper proportion of saving for a working class community is itself a subject which requires some study.

These points are of special interest in new communities where the working classes have large means. No good is done by using unsound arguments even for so excellent an object as the promotion of thrift. If examples are to be taken from other countries such as France, the so-called example should first of all be adequately explained, and a true comparison made, and then an inquiry made as to whether and how far the French example is sound and worthy of imitation. The fact already brought out as to the larger proportion of old life in France than there is in either Germany or the United Kingdom may also render saving a greater necessity there in order that as much may be got out of life as in the neighbouring countries. The requirements as to saving may thus be essentially different.

To sum up this branch of the discussion: what we may say is that the rough comparison of communities as regards moral characteristics based on statistics of education, crime, insolvency, and the like, is entirely useless and mischievous because the figures are of a kind that values can only be assigned to them by the most careful study. To take them haphazard from statistical abstracts and dictionaries, and assume that figures called by the same names in different countries have exactly the same values, is either foolish or dishonest. Dictionaries are for reference, and not intended to give all the materials for discussion, and when they are used for purposes for which they are not intended, all who are interested in the subjects under discussion must look out. Some dictionaries, however, might be made more useful than they are by the addition of a few notes to the figures, referring to such points as the nature of the legislation applied to the subjects of the figures, the mode of collecting the latter, and other vital qualifications of the figures themselves. I may claim the credit of privately stifling many an argument which inquirers were going to use by taking figures from books as they found them, because I

pointed out to them what different values the figures might have. But the dictionaries themselves could often put inquirers on their guard.

INDUSTRIAL STATISTICS.

I pass on next to a class of statistics which are still more frequently used for international comparison, viz., the statistics of production, industry, and trade. There is money in the comparisons here. There are competing policies whose merits are supposed to be capable of judgment by statistics. Or a country may wish to advertise its resources so as to attract immigrants or capital. There is also the patriotic bias or sentiment to be gratified or stimulated, or the anti-patriotic bias, which is really an inverted form of the patriotic bias itself.

The leading statistics thus used may be classed under the heads of agricultural production, manufacturing production, imports and exports, including shipping, wages, and finally accumulated wealth. The division is not a logical one, but it appears convenient for the present purpose, which is to explain the principal dangers into which the unwary in dealing with the vast branches of statistics included in this department are apt to fall.

As regards agricultural production then the initial difficulty of all the statistics is that which we have already had in dealing with population itself—the different value of the units which go by the same name. The wheat, oats, aud barley of one country, though called by the same names, are not the same as the wheat, oats, and barley of another country. There are the very greatest differences in quality, as any price list of London or other market, where grain from every part of the world is sold, would show. Yet nothing is so common as comparisons of the world's production of wheat, for instance, in which this difference of quality is ignored, and fine reasonings are indulged in where this difference of quality might seriously affect the result. What is true of grain is as true, if not more true, of live stock. There are sheep and sheep, cattle and cattle, horses and horses; in truth the agricultural live stock of any two countries, instead of being susceptible of ready comparison, can hardly be compared directly at all. The point is notoriously of great importance in historical investigations. In comparing England of the present day with the England of previous centuries the difference of the average weight and qualities of the live stock called by the same names has always to be considered. In nothing in recent years, as I understand, have some continental countries such as France made more remarkable improvement than in the quality of their live stock, so that with no increase in numbers, or little increase, there has been an enormous advance in real production. But the point is of equal importance in international comparisons. If Australia is to reckon with competitors in wool production, like the Argentine Republic, the average clip per sheep in the respective countries is obviously a necessary coefficient in the calculation, and it becomes of great importance to study in what countries the average is increasing or di-

minishing, and so on. Officials at the head of the agricultural department in France have been greatly impressed by considerations like these, and have endeavoured to substitute a count of cattle by weight for the mere count of heads, but even a correction like this would by no means be sufficient, as there might still be serious differences of quality. The comparisons, then, of agricultural production which one often sees, in which unlike units are taken as equal without more ado, and reasoned upon as if there were no qualifications, are most misleading. Rectification to any exact degree might not in many comparisons be possible, but the consideration of the point would usually make is possible to turn the figures to support some useful conclusion.

In connection with these comparisons, it should also be noticed that many of the deductions per head and per acre, into which it is usual to convert the figures of agricultural production, are calculated to mislead, even when the units themselves are comparable, because the comparisons are with the total acreage and total population of a country, and not with the special acreage and agricultural population. What could be more useless, for instance, than to compare two countries like England and the United States as regards their production of wheat or any other agricultural product per head of the whole population, the one population living on its own wheat and other products, and the other not. All such comparisons to be of any value should be made from the purely agricultural point of view—to illustrate differences in the style of agriculture carried on, or in the fertility of any two countries. But they are often made with lingering notions that all States can, to some extent, be dealt with as agricultural units, which is far from being the case.

Coming to statistics of manufacturing production again, and this to some extent applies to agricultural and mining production, what we find is that, save as to some particular industry in detail, and for the purposes of discussions of that industry by itself, there is really no common denominator between countries, except in so far as the production of their respective industries can be represented in money. The coal and iron of one country are not the same as the coal and iron of another ; the wool is not the same ; the cotton, woollen, and linen manufactures of the one cannot be expressed in the same units of quantity as the similar manufactures of the other ; the same with manufactures of metals, leather, and wood, and with machines of all kinds. Even if there is a general likeness in industrial characteristics of any two countries such as England and France, yet the different distribution of the leading industries makes any real comparison between the two as a rule impossible, except so far as it can be done in money. To make the comparison in money again presents new difficulties. The value of different kinds of production cannot well be reckoned up. A country like England, with the machinery of its income tax, has special facilities for reckoning up its income as far as possessed by individuals above a certain minimum ; but it has little official knowledge by com-

parison of incomes below that limit. France, again, has a special knowledge of its agricultural wealth, by means of the cadastre, and the system of registration and taxation of transfers of property, but it has not equal means of estimating its income from manufacturing. Money also is itself variable in value from time to time, as measured by the average of the commodities or services it is used to exchange, and in comparing two countries, as regards their production measured in money, no little care would be needed. I have seen few attempts to do so in which attention has been paid to the necessary conditions and difficulties, or in which the existence of such dangers and difficulties has even been recognised. The Americans in their census have attempted a great deal in this direction, but the least that can be said is that the result has not been encouraging.

Coming next to imports and exports, the point I would urge first is the initial difficulty of a bare comparison of the figures themselves. Imports and exports, instead of giving us easy statistics for many of the purposes for which they are used, are really very difficult. I refer especially to the values. Imports are stated in one country at the value of the goods as at the place of shipment; in another as at the place of arrival. In one country the basis of the statement is a declaration of the value by the importer, checked by the Customs authorities; in another there is an efficient commission of values, which takes note of market prices, and fixes official prices for everything at more or less frequent intervals. The same with the exports. The denominators are hardly ever the same in any two countries. The result is, that there are continual mistatements by amateurs on such questions as a comparison of two countries in respect of the progress of their foreign trade, or in respect of what is called the balance of trade. The falling off of the foreign trade of one country is contrasted with the growth of the foreign trade of another country at the same time, the truth being that in the one case, owing to the system of valuing by merchants' declarations, the volume of the foreign trade expressed in money responds instantly to variations in market price, while, in the other, owing to the system of official prices fixed at intervals, the volume of trade does not respond at once to variations in market price. In one country again what is called an adverse balance of trade appears to be larger in proportion than it is in another country, largely because the imports are valued as at the place of arrival, including freight and other charges to that place; while in the country with which comparison is made, the value is taken at the place of shipment, and does not include such additions. In the latter case, therefore, the exports form a total more nearly approximating that of the imports than in the former. All this confusion is due simply to the fact that the units of the imports and exports are not, in fact, the same. The record is not made in the same way.

Assuming, however, that the record is made in the same way formally, there remain some essential differences in the foreign trade of different countries, which make comparisons between them most difficult, and it is mainly to one or two of these

essential differences I would now desire to call attention.

First of all, there are the differences which I discussed at length in a paper I wrote long ago on "The use of Import and Export Statistics,"* due to the facts that a nation may be largely engaged in the business of carrying goods for others, or may have made large investments abroad, on which it is entitled to dividend or interest, while another nation may have its goods carried for it, or may owe large dividends and interest. In the former case, a large amount of imports is required to set off the balance due to the nation concerned, quite apart from what is required to set off the exports officially recorded as such. In the latter case a large amount of exportation is required to set off the balance of indebtedness with which the nation, as it were, begins its import and export account. The character of the foreign trade of the two classes of nations is essentially differentiated all the way through for those reasons. It may be found afterwards that in fact a nation in the first class exports as much, or nearly so, as the official record of its imports; or that a nation in the second class imports as much, or nearly so, as the official record of its exports. But the inferences would be very different as to the economic conditions implied. In the first case the near balance of imports and exports would imply that the nation in question is at the time lending largely to other communities. In the latter case the inference would be that the nation in question is borrowing largely, for useful or useless purposes as the case may be. Before the statistics can be handled at all, in short, so as to throw light on the economic conditions, the standard of equilibrium has to be adjusted to allow for the other elements described.

England, I need hardly add, is a conspicuous example of a nation in the first-class, its freight carrying and its investments abroad being both enormous. But France, Belgium, Holland, Germany, and the Northern nations of Europe are all more or less in the same category. On the other hand the United States of America, India, Australasia, the South American countries, and many more are all nations in the second category, having their carrying trade done for them, and having dividends and interest to pay to nations in the first category. But there is much discussion on relative import and export statistics in which these essential differences are lost sight of, and imports and exports are treated as if in all cases they were the same.

The next point I would urge is that the imports and exports of what I would call an *entrepôt* country are not of the same species as the imports and exports of a country which has a direct import and export trade only: that is, which exports its own home produce on the one side, and imports articles for final consumption on the other side. A country which largely receives either raw produce or produce in different degrees of advancement towards the form in which it is finally consumed, and then, after manipulating that produce to a greater or less extent, re-exports it, has obviously a very different kind of foreign trade from a country which manipulates nothing or hardly

* See Essays in Finance, 2nd series.

anything it receives, and does not re-export. The imports and exports in the respective cases have not the same relation to the general economic conditions of the countries concerned. To compare the *entrepot* country with a country which has only direct foreign trade, so as to show the volume of imports and exports in respect of what is received for final consumption and what is exported of the labour of the country, it would be necessary to deduct from both sides of the account of the *entrepot* country the value of the produce imported and afterwards re-exported in a manipulated form. In this way, I am sure, the imports and exports of the United Kingdom would be largely reduced from what they appear to be, and the United Kingdom would not appear to import so much more than some others for final consumption, or to export so much more than some others with which to obtain purchasing power abroad. Reckoning in this manner, I am not sure but that Australasia would appear even more at the head of exporting countries than it now does, the labour per head represented in its exports being truly enormous. Some countries, such as Belgium and Holland, again, would have their tale of imports and exports reduced even more than that of the United Kingdom, as their business is so very much a business of transit only. In any case these are points obviously requiring consideration, when the imports and exports of different countries are compared or contrasted. They ought not to be put together at all in any discussion till they are reduced to common denominators.

Another point I would urge is the importance of the question of size and general similarity in conditions in comparing the volume of the foreign trade of any two countries. If the United Kingdom were to be split up, and Ireland, say, were to have separate customs, the foreign trade of Great Britain would be enhanced by the addition to the account of the imports from Ireland on one side, and the exports to it on the other, which would then become foreign trade, deducting, however, the present imports into Ireland from foreign countries, and the exports from it to foreign countries which are now included in the foreign trade of the whole United Kingdom. If Holland again were to be united with Germany, and Belgium with France, it is doubtful whether the foreign trade of both Germany and France would be increased very much, and might not even be diminished, so much of the foreign trade of Germany and France being now with Holland and Belgium; while the aggregate foreign trade of the world would be diminished by the elimination of the two countries named as separate countries, and they would no longer appear as having the largest amount of imports and exports per head. In the same way the formation of the Australasian countries into a federation with a single Customs frontier would greatly diminish the volume of imports and exports as now stated. According to Table B appended, the imports of the Australasian colonies added together, for the year 1889, amounted to about £69,043,000, and the exports to £62,706,000; but if we separate what each colony imports from and exports to the rest of the world, excluding what it imports from and exports to its neighbours, the

total would be £40,481,000 only for imports, and £35,902,000 for exports. These would be the proper figures to use in a comparison with other countries, such as Canada or the Argentine Republic, in more or less similar economic conditions. Compared with either of these two states, and assuming for the present that the figures are made up in much the same way, as I believe is the case, the foreign trade of Australasia comes out at about double that of either of the countries named. Its exporting power is so much greater than theirs. This is a true comparison. But a comparison in which the intercolonial trade is not eliminated would give an altogether untrue notion. Australasian foreign trade would appear about thrice or four times that of Canada, instead of about double only; and this would be a false comparison. The truth is favourable enough to Australasia.

Generally, however, I should like to add that the selection of foreign trade, as specially a test of the welfare of nations, does not seem to be in any way justified. Whether the foreign trade of a given country is large or small in proportion to its whole production is an affair to a large extent of size or of historical evolution, and nothing can be made of comparisons unless attention is given to the point I have already suggested—that of size and general similarity of conditions. But it is quite conceivable that nations might approximate to each other in many respects, and the one have a large foreign trade and the other not, yet both be in much the same condition of individual prosperity. Accident might determine that the one should be more self-contained than the other, so that its exchanges with other countries should bear a less proportion to its total industry. France and England are very good illustrations of essential differences of this sort, England having much more manufacturing, shipping, and foreign trade than France, but France being certainly a highly prosperous nation, with home industries of different kinds which England either has not at all or not to the same degree, and the products of which are only or largely obtained in England by exporting something else. All these general comparisons between nations in which the foreign trade is spoken of or assumed to be representative of the total trade are, therefore, very much to be deprecated. Import and export statistics, apart from the special danger of using them, which I have described, cannot be properly used for such comparisons.

I come next to international statistical comparisons in respect to wages, which present some curious difficulties of which most of those who make such comparisons seem totally unaware. In the primary use of records of wages, viz., their use by the labourer or workman, who has no employment, or small wages in one place, and finds he can better himself by going to another, these difficulties do not arise. If the facts recorded are true, the labourer or workman has something on which to act, and he can attend to all the points and qualifications necessary. But when the same records are used, or an attempt is made to use them, for more general purposes, difficulties begin. Length of working day, continuity of employment, and other points must all be

recorded when a general statistical account of the wages-earning classes of a people has to be built up. So little have such matters been studied, however, that I doubt the existence of any comparison of wages in different countries which is even formally complete. No country has, as yet, a tolerably complete account of its own wages in which attention is given to all these points; much less is there any possibility of international comparisons.

As the primary records are, however, sometimes used for such comparisons, and we get such statements based on them as that wages are 50 or 100 per cent. higher in the United States, say, than in England, special attention may be drawn to the failure of the comparison in point of logic. In the absence of any account of length of the working day and continuity of employment, no proper comparison can be made. This applies specially to a comparison between wages in out-of-door trades in a country like the United States, with a severe climate, and wages in the same trade in England. Wages in the former country may well be higher per nominal day or week of actual work, and yet the difference not be so great when the earnings and hours of labour of the whole year in England are reckoned.

What I would most desire to direct attention to, however, is the statistical importance of a somewhat different point. This is the distribution of the population according to remuneration. It is quite conceivable that in one of two countries the earnings, and still more the nominal wages, may be higher than in the other in every single employment which can be enumerated and compared, and yet the average earnings of the average wages-earning man may be higher in the latter country than the former, the reason being the different distribution of the people according to earnings. This can be shown very clearly in a theoretical comparison. Take first a community of 1,000 wages-earners, with the people distributed according to earnings, in the following classes—A, B, C, D, and E—as follows:—

FIRST COMMUNITY.

Class.		Per Annum.	Nos.	Total.
A.	Earnings ...	£50	500	£25,000
B.	„ ...	60	200	12,000
C.	„ ...	70	100	7,000
D.	„ ...	80	100	8,000
E.	„ ...	90	100	9,000
	Total ...	... ...	1,000	£61,000

Average per head, £61.

And compare this with another community of equal numbers, in which there are also five grades, each remunerated at a lower rate than the corresponding grade in the first community, but

in which the average of the whole is higher because of the different distribution of the people among the grades :—

SECOND COMMUNITY.

Class.			Per Annum.	Nos.	Total.
A.	Earnings	...	£40	100	£4,000
B.	"	...	50	100	5,000
C.	"	...	60	100	6,000
D.	"	...	70	200	14,000
E.	"	...	80	500	40,000
		Total ...	... ...	1,000	£69,000

Average per head, £69.

In a comparison of rates of wages merely according to the nature of the employment, the wages in the first community would obviously appear higher than in the second, and this would be strictly true in a sense ; but the inference would be untrue that the average earnings of the wages-earning classes in the first community, striking a true average, would be higher.

The principle of this theoretical comparison I believe helps to explain the actual facts as between an agricultural new country like the United States or Australasia, and an old country like England. In the former agricultural wages are higher than in England, and almost every sort of employment, subject, however, to some qualifications, such as length of day and continuity of employment, is better paid than in England ; but it is a *non sequitur*, not at first apparent, that the average earnings all round are also higher, the truth being that owing to the larger proportion of artisan classes in England the average earnings of the working classes may be as high or higher in England than in the United States, or at any rate not very far short. The mode of comparing wages in two countries is thus a most critical question. I have been often puzzled myself to explain how it is that we arrive in England at comparatively high figures for the aggregate income of the nation when most of the rates of wages are apparently so much lower—employment for employment—than they are in the United States or Australasia, and to a large extent I believe the solution I have now suggested is the true one. It is not enough, then, to compare employment with employment, but mass must be compared with mass.

Other dangers in these international statistical comparisons, such as differences in the purchasing power of money in different places may be suggested. But I should not be disposed to lay so much stress on any other point as upon that of the relative importance of different employments in different countries. In these days of cheap freights and rapid transit, the equalisation of prices in all countries has been carried very far indeed, the most important differences that remain being, I believe, artificial, arising from the protection of food products in countries like Germany and France, and the like causes. The different distribution of populations according to employments remains, however, an enduring cause of differences in their relative aggregate earnings and average earnings per head.

WEALTH STATISTICS.

Finally I have some remarks to make on the dangers of comparisons between nations as to their aggregate wealth.

Apart from all other difficulties that of the data themselves is here very great. It is hardly possible to obtain an account of the wealth of any country on any basis that can give a minutely accurate result, and it is the more difficult to obtain such accounts for any two nations made up in exactly the same way. If one country, therefore, is made out to have an aggregate wealth of about £250 per head and another £300 per head, it may well be that, owing to the necessary want of exactness in the calculation itself for any country and the differences of method employed in each case, the facts represented by these figures may either be much the same, or the country whose wealth is computed at the smaller figure may really be the richer of the two. Before any comparisons can be made at all, then, the methods observed in each case must be carefully followed, and particularly it must be observed whether they are likely to give a rack valuation or not. My own impression is that, except where the differences are enormous by almost any method of calculation, but little can be made of differences between country and country. Figures that are within sight of each other as much as are £250 and £300 per head, provided much the same methods have been followed, are practically much the same thing.

The comparison, also, is of little value unless accompanied by statistics of relative income, statistics of the sources of the wealth or income, and the like information. Accumulated wealth is only one element of economic strength.

A special point of great difficulty is how to deal with the wealth of a community which includes individuals having large investments abroad, and with the wealth of another community which is indebted to persons resident abroad in its public capacity, and whose individual members are also indebted to members of other communities. To a certain extent the foreign investments of a community in the first case are not available resources. Suppose the investments to be made in a foreign country with which it goes to war, the whole resources which are counted part of its wealth would really count on the other side. In the same way a country which has borrowed largely has the whole wealth really available for many purposes without any deduction for what it has borrowed. In war with a community from which it had borrowed this would at once be apparent, but in other contingencies, also, the indebtedness is not a real deduction, the wealth belonging to the foreign non-resident never being really taxable as if he were resident. I have thought it expedient in my own calculations of the wealth of the United Kingdom to include the foreign investments of the members of the community at home as far as possible, and similarly I would make a deduction in the case of an indebted community equal to the amount of its indebtedness. All this, however, would be on the assumption of a continuation of peace and subject to the qualifications that in certain circumstances a different calculation would practically requireto be made.

There is one point in addition to be noticed in regard to the method of these calculations. Where property in two countries appears to be subject to a tax like probate duty or income tax on apparently much the same basis, the temptation is very strong to apply the calculated amount of such property per head to each nation respectively, but nothing could be more dangerous owing to the difficulty of the data. The laws and their administration of the respective countries compared would need careful examination before any such short cut could be used, and even then one ought not to be too sure of any single method. Unless some detail could be given, no such method should be employed except as a check on a more detailed method. Such a method is also specially dangerous when the wealth of a community is arrived at without any items being given ; by such a method, for instance, as that of dividing the average wealth subject to probate duty in a year by the numbers dying in a year, assuming the wealth per head thus arrived at to be the average wealth per head of the community, and then multiplying the numbers of the community by that figure so as to arrive at the aggregate wealth. The method may yield useful results if care be taken to establish *aliunde* what is the relation between the wealth per head of those members of a community who die within a year, and the wealth per head of the members of a community as a whole, but when no such care is taken, and communities are compared whose probate and income tax laws are not really the same, the result of the comparisons may be the merest chance.

CONCLUSION.

The conclusion of this long review may be very shortly stated. All the leading branches of statistics without exception, when examined, give numerous illustrations of the dangers of taking the figures relating to them from dictionaries or works of reference at haphazard for international comparison, as if the figures called by the same names in different countries meant the same things, or the units had the same values. On the contrary, from the simplest figures as to population and area, through the more complex figures as to the moral qualities of communities indicated by statistics like those relating to education and crime, down to the still more complex figures relating to production, trade, and wealth, the same tale is told as to the necessity for constant watchfulness lest things that are really unlike are put together as if they were like. The moral is what was stated at the outset, that the figures as such may be right enough, though there are many difficulties as to the data themselves to be faced in statistics, but the exact meaning of the figures called by the same name, when place and circumstances are different, may require a great deal of elucidation. Perhaps some may think that the difficulties are so great as to make it hopeless to handle most statistics in such a way as to reach any conclusion. This is, however, by no means the case. When care is taken true conclusions begin to appear, and a picture is obtained of the general conditions of communities in the mass which would otherwise be unattain-

able. The negative results which are the effect of the criticism applied to the rough and ready methods of amateur statisticians are also valuable and important. There are so many errors about respecting the conditions of most communities, partly derived from, and partly nursed by, the rash use of statistics with a more or less conscious bias towards a desired conclusion, that it clears the air to have a demonstration of the impossibility of these errors being proved to be true. When one knows, for instance, how intrinsically difficult it is to prove statistically the greater prosperity of one country than another when the differences between them are not very great, it is not difficult to estimate at its due weight any argument in which the difficulties are ignored and statistics are dealt with by short cuts when they seem to support the side on which the arguer has ranged himself. If we help by this discussion to strengthen the wholesome attitude of doubt, and to discredit the short cuts of the amateur partisan, the discussion, it may be hoped, will not have been wholly in vain.

TABLE A.

Total Population, and Total Male Population above age of 20, in the Undermentioned Countries (according to the latest information available).

—	France. (Census, 1886.)	Germany. (Census, 1885.)	United Kingdom. (Census, 1881.)
Total Population	37,930,759	46,855,704	34,884,848
Total Male Population	18,900,312	22,933,664	16,972,654
Total Male population above age 20 ..	11,828,363	12,435,796	8,898,529
Total Male Population between 20 and 40 ..	5,376,254	6,577,383	4,838,585

TABLE B.

Statement showing the Value of Imports and Exports into and from each of the Australasian Colonies during the year 1889 from and into (1) the remaining Australasian Colonies and (2) all other Countries.

Colonies.	Imports.			Exports.		
	From Australasian Colonies.	From other Countries.	Total.	To Australasian Colonies.	To other Countries.	Total.
	£	£	£	£	£	£
New South Wales	10,647,312	12,215,745	22,863,057	10,741,045	12,553,889	23,294,934
Victoria	8,539,854	15,862,906	24,402,760	4,022,054	8,712,680	12,734,734
South Australia..	4,045,691	2,758,760	6,804,451	3,283,734	3,975,631	7,259,365
Port Darwin, N.T.	132,054	62,290	194,344	87,836	32,380	120,216
Western Australia	334,969	483,158	818,127	147,557	613,835	761,392
Tasmania	1,037,078	573,957	1,611,035	1,208,006	251,851	1,459,857
New Zealand ..	1,107,132	5,189,965	6,297,097	2,145,671	7,193,594	9,339,265
Queensland ..	2,717,671	3,334,891	6,052,562	5,167,790	2,568,519	7,736,309
Total	28,561,761	40,481,672	69,043,433	26,803,693	35,902,379	62,706,072

2.—THE ORGANISATION OF INDUSTRY.

By ALFRED DE LISSA.

(Diagram.)

THE one great problem of civilisation is to give to the masses in civilised countries the means of supplying wants which civilisation renders, increasingly with advancing time, in a more or less degree, necessities of life. That population did increase in the ancient world faster than the means of subsistence, and does so increase now, where nature is unaided by the progress of science and invention, are probable facts; and there appears to have been ground for the contention of those who have concluded that the Gorgon law of war, pestilence, and famine was nature's remedy, and was necessary in the past ages to decrease the numbers of life. The mind of the nineteenth century repels such an idea in connection with its civilisation. It would be an evident fallacy to say to economists that the progress of knowledge, science, and invention have decreased the means of subsistence, or that which may be the same thing, the means of employment; yet, there are writers and speakers who assume and even assert that this is the case, and that the most advanced civilisation brings with it lessened means of sustaining life for large masses of people in every country. The condition referred to is thus stated by Henry George—"Where the conditions to which material progress everywhere tend are most fully realised, that is to say, where population is densest, wealth greatest, and the machinery for production and exchange most highly developed, we find the deepest poverty, the sharpest struggle for existence, and the most enforced idleness. It is," he says, "in the older countries—the countries where material progress has reached late stages—that widespread destitution is found in the midst of the greatest abundance." He speaks of the "new communities where Anglo-Saxon vigour is just beginning the race of progress, where the machinery of production and exchange is yet rude and inefficient—where the increase of wealth is not great enough to enable any classes to live in ease and luxury—where the best house is but a cabin of logs." Of such a stage of progress he says "there is no luxury, but there is no destitution, and everyone can make a living." He then remarks, in reference to the progress of such a community, "that as the greater utilisation of labour-saving machinery makes possible greater economies in production and exchange,

and wealth in consequence increases, not merely in the aggregate, but in proportion to population, so does poverty take a darker aspect. Some get an infinitely better and easier living, but others find it hard to get a living at all. The tramp comes with the locomotive; almshouses and prisons are as surely the marks of material progress as are costly dwellings, rich warehouses, and magnificent churches. Upon streets lighted with gas and patrolled by uniformed policemen, beggars wait for the passer-by, and in the shadow of college, and library, and museum are gathered the more hideous Huns, and fiercer Vandals, of whom Macaulay prophesied."

What are the true causes producing the results so fully and graphically described by Henry George? Is the deepest poverty, the sharpest struggle for existence, and the most enforced idleness for large numbers the result of civilisation? Is it the case, as stated in the words of a recent writer, "that there is something in the law of growth in human society unfriendly to its masses, and unduly favourable to the advanced classes of wealth and condition?" It must have occurred to many thousands who have given thought to the great problems of life, how slow is the material progress of the masses,—how tardy is reform. There must be some amelioration as time creeps on, but poverty and destitution, the same grievous struggle for existence, among vast numbers in a community, continue. The evils seem to increase with a country's growth, until they appear to be too great to grapple with. To quote again from Henry George—"The association of poverty with progress is the greatest enigma of our times. From it come the clouds which overhang the future of the most progressive and self-reliant nations. It is the riddle which the Sphinx of Fate puts to our civilisation, and which not to answer is to be destroyed." There are hundreds of thousands living on the continents of Europe and America in the most degraded conditions of life, with whom hope is dead, to whom joyfulness is unknown, toiling incessantly for the barest means of sustaining what is to them the burthen of life. Arnold White, writing of London, says—"Night by night and day by day rises through the canopy of smoke the lamentations of those who rue the day they were born. I have seen men praying for death to end the hapless misery,—the want of food and want of work." "Compared with the nomadic tribes of tropical countries where the curse of civilisation (it is strange to hear civilisa-

tion spoken of as a curse) is unknown, the nomads of London are but miserable savages." John A. Hobson, M.A., some time Scholar of Lincoln College, Oxford, remarks in his "Problems of Poverty"—"Modern life has no more tragical figure than the hungry labourer wandering about the crowded centres of industry and wealth, begging in vain for permission to share in that industry, and to contribute to that wealth, asking in return, not the comforts and luxuries of civilised life, but the rough food and shelter for himself and family which would be secured to him in the rudest form of savage society."

To the question raised by these utterances, the answer must be that civilisation has not yet secured the means of supplying to numbers who throng every large circle of civilisation the wants which civilisation renders necessities of life. To the question whether the growth of civilisation is unfriendly to the great masses of humanity, whether they are worse off than they were, or would be, without the progress of science and knowledge, and of the thought which discovers new forces to aid humanity, whether there is less employment, the answer must be, No. Is the labourer in India, living on rice and pulse, costing one shilling per week for his subsistence, better off than the European? Do masses of Chinese living in large numbers in apartments smaller than Europeans ever dreamed of, sleeping on shelves fixed along the wall, lead a higher condition of life? Was the English labourer better off in the thirteenth century? His condition then was very much that of the Hindoo labourer now. Would the world sustain larger numbers—would there be more employment if there were no steam power, no machinery, no railways, no chemistry, no science, which have increased so vastly the productions which feed and clothe the human race? The term poverty, or that which we understand by it, is so far the result of civilisation and development that the wants which civilisation brings are not supplied to large numbers in civilised lands. These wants do not exist in the lower stages of development; they are unknown and unfelt in the heart of the savage, who rests in the shade of the fruit-laden tree. Can any say—

> "There, methinks, would be enjoyment, more than in this
> march of mind,
> In the steamships, in the railways, in the thoughts
> that shake mankind?"

Although such may be the reflections of the most abject

under the influences of civilisation, in the lands most brightened by its sunlight, yet to the vast majority civilisation, and the education which it now rightly gives, have brought intelligence and aspiration, and, in a more or less degree, refinement of thought and feeling. It is not with the multitude as it was in ancient times, as it is in the eastern lands to which I have referred, where there are two widely separated classes—an upper class, enormously rich, and a lower class of most inferior condition. Degraded labour seeks no progress, and but serves the purposes of an employing class. Winwood Reade, speaking of Greece, and referring to the fact that half its inhabitants were slaves, says—"The upper part of the Greek body grew, the lower part remained in a base and brutal state discharging the offices of life, but without beauty and without strength. The face was that of Hyperion, the legs were frightful and hideous, as those of a Satyr." And now it is not only those who have the sharp struggle for existence, but the hundreds of thousands who are enabled to command but in a very small degree the refinements of life which fall to others, and feel keenly, in a civilised land, the absence of that higher civilisation which elevates life and betters its condition, who are seeking and searching everywhere for means of amelioration; and in the desire to set on foot reform have arisen those who advocate socialistic theories, which would make the State the possessor of all means of production, abrogate property, and destroy the individuality which is the soul of aspiration and achievement, the individualism which has been the mainspring of the grand result of progress. These ideas are current among large numbers of the population of every country to a far greater extent than most men will admit, and deficiencies of civilisation, or the deficiencies of thought and action, no less than the discontents which prevail, threaten the upheaval of society in many lands.

The true indictment against society in older countries is the mental inertia, the soulless indifference, which characterise the majority of large and influential sections of the community—the possessors of wealth, the votaries of pleasure and fashion; the politicians, whose sole policy is that of *laissez-faire*, whose only principle of action is the expediency of the passing hour; the general disregard of the necessity in the cause of humanity, in the interests of government, of peace, and freedom for action of some kind, the best available, as the one paramount consideration. Is it possible for economic science

to indicate what that action should be—the true remedy, having regard to existing conditions, which shall control the elements of conflict retarding progress, and render the achievements of thought and science conducive to results more worthy of mankind? If it is possible in a new land like Australia to do so by departing from the old grooves of thought, and recognising new modes of action, it is for the exponents of economic science to indicate what they should be. It is for them to put forward propositions based on sound principles for recognition; to become the public opinion, which is now formed by the exercise of thought among the masses, and, possibly, nowhere to a greater extent than in Australia, which is formed by workers in every field of mental and physical employment, not only by the more intellectual portions of the community, but in every cottage, in every bush settlement, and around the pit's mouth of every mine. It is for the exponents of economic science to revise our institutions, to put forward any new theories for action which may be entertained. It will not, except in a few, or rather a very few exceptional instances, come from the politician, who becomes more and more a delegate in every democratic community. His advancement depends upon being the exponent of public opinion, and, with few exceptions, he does not seek to lead it.

I believe that in a new country like Australia it is possible to set on foot material measures of reform, not for the reconstruction of society, but in the organisation of the industrial system; that it is for an Australian community to initiate promising reforms tentatively. As the twig is bent the tree inclines. It may be possible in some instances to promote a new growth. There are giant industries in their infancy, or not yet started, which may be dealt with in the first stages of progress as they could not be dealt with in the older lands. Above all, the data which economic science can give should be forthcoming. The data and axioms of that science, to be recognised as axiomatic truths, are like the data and truths of mathematical science which are observed in the work of material construction; the data and axiomatic truths of economic science necessarily underlie the whole structure of social and industrial life.

For economic science to put forward any such data for the purpose of the inquiry suggested it must probe the industrial system; it must trace as far as possible its operation; its attention should be especially directed to two phases of the

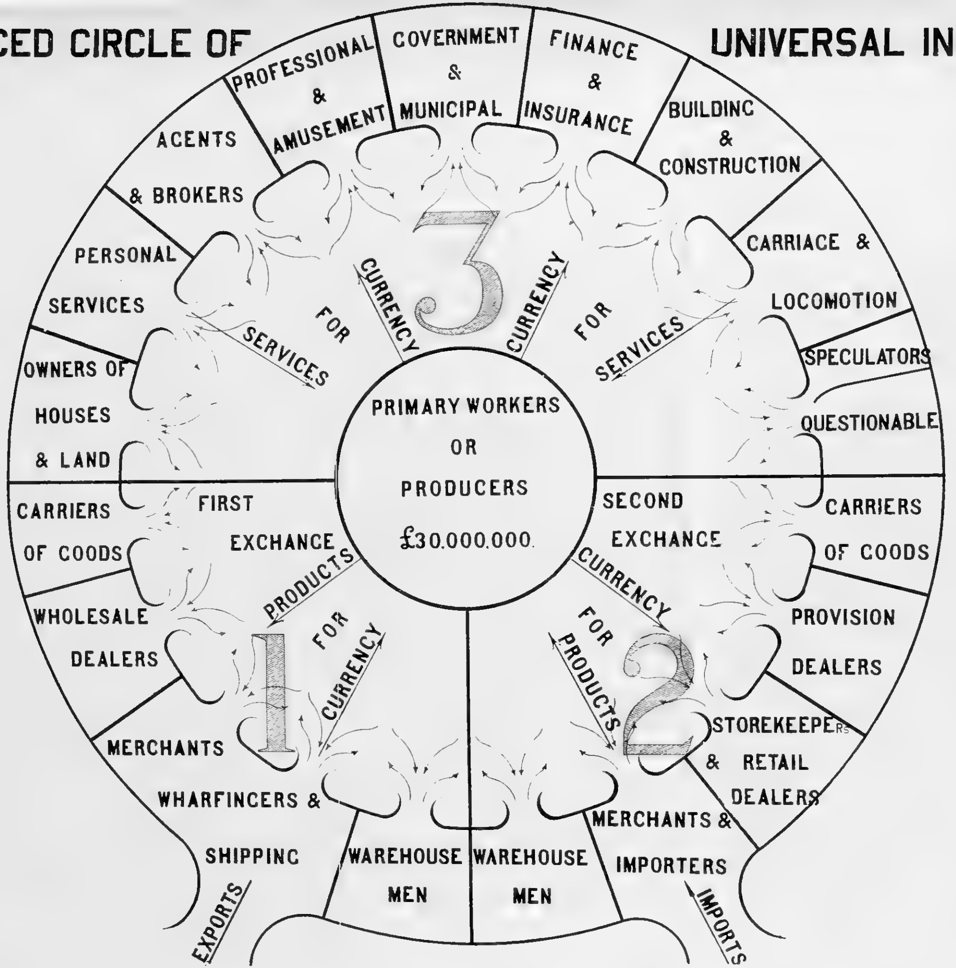
industrial system—the production of a country, and the measure of the wealth it gives in the employment of the people—the two intimately associated together, so closely entwined as to be virtually inseparable. To arrive at correct conclusions one idea should never be in mind without the other, or, rather, the idea should be dual in its nature—production, and the measure of its employment.

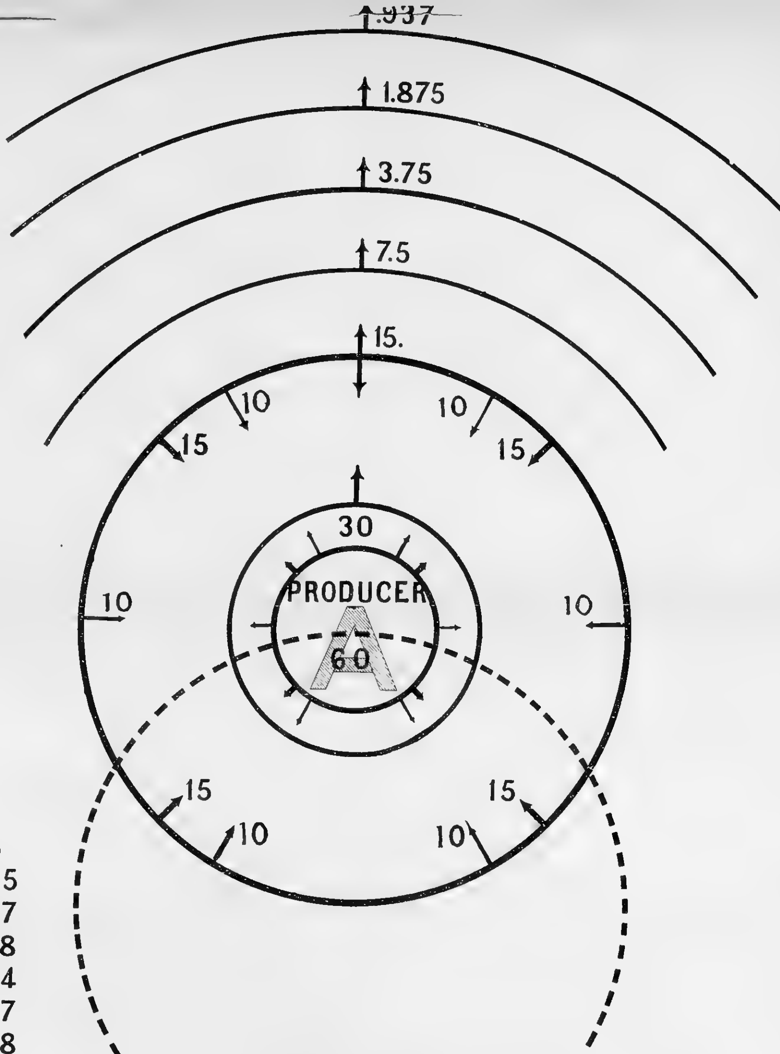
In the application of this dual idea, a better classification of the workers in a community suggests itself than has hitherto been put forward by the statistician, and one which may be regarded as a natural classification, which, in some respects, forms itself. We must seek through the primary production of a country the classification of its workers, and it will be found that such classification leads to important results and data which have not hitherto been considered, and indicates the operation of the industrial system in a more systematic, and in a clearer way, than could be otherwise ascertained.

Let us place in the centre of a circle those engaged in the work of primary production, whom I designate "primary workers." I have shown them at the centre in this diagram (No. 1) or circle of universal industry (a term I have borrowed from one of the economists), and I have placed at the circumference all other classes whom I designate "secondary workers," including in that term, to avoid repetition, the owners of realised wealth. The primary workers will include agriculturists and all others employed in procuring the products of the soil, pastoralists or graziers, manufacturers of every kind and character, all engaged in mining, quarrying, forestry, and fisheries, capitalists, employers and employed.

This diagram was prepared to indicate the circle of industry in New South Wales, where the production of these primary workers is about £30,000,000. The incomes of all classes,—all wages, profits, rents, interest, earnings of every kind and character in New South Wales,—have to be furnished by these products. Although it is superfluous to indicate the fact, and a reference thereto in addressing economists needs apology, yet, as it is necessary for others to understand, I have to indicate that all incomes are virtually indicated by product—the coin which men receive is but the medium of exchange. If crops fail the incomes of the farmers are gone, together with the incomes of all who derive earnings through their expenditure. If stock die, the income of the grazier is lessened by the amount which would represent the production of the stock and of the wool. When the product is not pro-

ENLARGED CIRCLE OF UNIVERSAL INDUSTRY





15.
7.5
3.75
1.875
.937
.468
.234
.117
.058
.029
.014
29.982

BASTIAT'S

CIRCLE OF UNIVERSAL INDUSTRY.

duced the equivalent of coin is not in circulation. A certain amount of the product is virtually or actually received by the secondary workers in exchange for services. If the produce dealer, who is also a carrier, purchases ten tons of hay on a farm at £2 per ton, which he sells at £2 10*s.* in the market-place, when he has sold eight tons he will get back the amount of capital he has expended, and the remaining two tons will in part represent his income. When it is sold he receives the equivalent of coin. And, in like manner, when ten million pounds' worth of wool (being the approximate amount) leaves the stations of New South Wales, if four-fifths of it, being the value of eight millions on the station, fetches ten millions in the London market, the remaining two millions will represent the incomes of the carriers, merchants, wharfingers, shipowners, and seamen who derive incomes from their services in dealing with the wool. I have shown, in the left-hand segment of the lower portion of the circle, marked No. 1 in red, the first exchange as regards the primary workers, the produce passing from the producers at its primary value, in exchange for currency, into the first hands receiving the product, who derive incomes from dealing with it—the wholesale dealers, merchants, shippers, and warehousemen; and I have shown in this division the portion of the product leaving the country in the shape of exports. The segment on the right, in the lower portion of the circle marked No. 2, shows the second exchange as regards the producers, and virtually represents the market-place where are located the warehousemen, the retail vendors and purveyors, the second and third hands receiving the product and imports for which the exports are exchanged. Here each producer pays a higher price for the product he consumes than the primary value at which it was originally sold, the difference partly representing the earnings of the numerous classes in the lower portion of the circle. In the upper portion of the circle marked No. 3 I have shown currency passing from the producers to the classes at the circumference in exchange for services. The circle shows the exchanges as regards the producers. Place each of the classes in turn at the centre of the circle for the purposes of expenditure as regards sections 2 and 3, and the cycle of operations in the distribution of the product will be complete. It is not generally realised what numerous classes are comprised in the division of secondary workers who are not

engaged in the work of primary production, and who have to receive incomes out of the annual product. They are shown at the circumference of this circle. They include all engaged in commerce and trade, retail dealers of every kind and character, including the purveyors and modifiers of food; carriers of goods, and all others employed in dealing in any way with the produce. These classes are no doubt producers in one sense of the term. The carrier or cattle-drover, the cattle-dealer, the carcass butcher, the retail butcher, the man who drives the butcher's cart, and the cook who prepares the meat, are all producers of the joint which is placed upon the table. Those shown in the circumference have been and are sometimes called non-producers. I do not designate them by that term; I call them secondary workers. My classification has reference to the primary work of production, which can be affected by legislation, or which may be particularly the subject of organisation. The great division of secondary workers referred to will also include those employed in the shipping trade, ironworkers and others engaged in the repair of ships and partially in their construction, underwriters and marine insurance companies, dock and shipyard employés. All these classes virtually receive their incomes out of the product. Mr. Giffin has been the first to point out that there are what he has termed the "invisible exports" of a country in connection with the shipping trade—ships that go down covered by insurance, stores, fuel, and the services of those to whom I have referred. Money is earned abroad replacing the expenditure, the whole profit in the United Kingdom being estimated by Mr. Giffen at about $12\frac{1}{2}$ per cent. The secondary workers receiving incomes out of the product will also include the owners of houses and land yielding rents, not included in the class of primary workers; all engaged in personal services, agents and brokers, the numerous classes in the ranks of professional and amusement, including authors and those engaged in mental pursuits; the Government services, including the army, navy, and police of a country; municipal labourers; those engaged in building and construction, including contractors of every kind, and all engaged in the building and finishing trades, so far as the average of annual savings so employed will represent part of the year's product. The employments in this division derived from the expenditure of capital will to some extent act upon and stimulate production; the personal carriage

and locomotion; speculators, as far as incomes are derived from the products of the year; the criminal and questionable classes.

Inasmuch as all the incomes earned in a country, and the means of livelihood of the numerous classes at the circumference so derived, have to come from the centre of the circle, it is desirable to ascertain, if possible, the result of any specific or additional production, the measure of its wealth, how far it will benefit and find employment for all classes; to ascertain what relation, if any, the incomes of the secondary workers bear to the incomes of the primary workers or producers. This relation has never been considered, so far as I am aware, by any writer or economist. I find a passage in M'Culloch's introduction to Adam Smith's "Wealth of Nations," in reference to Quesnay, as follows—"The Tableau Economique, a formula constructed by Quesnay to exhibit the various phenomena attendant on the production of wealth, and its distribution among the productive, proprietary, and unproductive classes, published at Versailles in 1758; and the novelty and ingenuity of the theory which it expounded, its systematic and scientific shape, and the liberal commercial policy which it recommended, speedily obtained for it a high degree of reputation." I find that this work has been lost, or at all events but one or two copies only exist in some European libraries, but it would not have exhibited the same result as I am indicationg—his general distribution of the workers (as stated by M'Culloch) being different. But the course which he took in tracing the phenomena attending the distribution of wealth is that which I am taking now. It is to be regretted that the results of his work, whatever they may be, are not given by any of the modern economists.

With the classification of the workers indicated by this diagram or circle, it will be found that, whatever may be the incomes of the primary workers in a country, that the incomes of the secondary workers will approximately be an equivalent amount; and I find this is indicated by statistics of every country for which the necessary figures are available. The classification gives the indication of a law which I designate "The Law of the Incomes." It is ascertained by taking the figures of primary production at the point of production, that is to say, in this diagram, the value of the stock upon the stations, the crops upon the farms, the goods in the factories, the minerals at the pit's mouth, &c., before another hand

has touched them—minus the raw material operated upon in each industry—these figures representing the primary production of the land. The relation between the incomes of the primary and secondary workers which I am indicating has no doubt not been observed before by reason of these figures not being usually given in the aggregate by the statistics of a country. They represent the value of the product, minus the raw material operated upon, not the subject of production in the particular industry for which figures are given; that is to say, the value of the grain less the value of the seed, the value of the flour less the value of the grain, the value of the leather minus the value of the hides, the value of the boots minus the value of the leather, &c. The statistics of the different countries, as generally stated, give in the aggregate the total value of the different manufactures or divisions of production: thus, the manufactures of the United Kingdom, stated for the year I dealt with at £818,000,000, after deducting in this way the value of the raw material operated upon, will be represented by £334,000,000. The manufactures of the United States, stated at £1,112,000,000, will be represented by £404,000,000. The figures of production taken in this way, minus the raw material, necessarily represent the incomes derived from the work of primary production; that is to say, the wages of the labourers, the profits of the capitalists, receipts derived from the rental of lands applied to productive purposes, and interest on money so employed, and also the partial incomes of men as producers who are partly employed or otherwise employed at the circumference of the circle. The figures of production taken in this way, and quoted in the aggregate, give the incomes derived and the value of the employments in the work of production as they can be asertained in no other way, as they could not be obtained by any independent classification of the workers. When the figures indicating the value of primary production, or the incomes of those engaged in the work, are compared with the figures showing the total incomes or total earnings of the people, it will be found that the total incomes are approximately double the amount of the production, the incomes of the secondary workers being approximately the same as the incomes of primary producers; or, to state it in another way, the incomes of primary workers or producers give corresponding incomes to all other classes according to the demand for their services.

I find the approximate result stated, after the necessary deduction for the absentee incomes leaving the country and the English capital coming in, for the Colony of New South Wales; for Victoria; for the whole of the Australasian Colonies, according to the figures quoted by Sir Henry Parkes at the recent Federation Conference. For the United Kingdom I have taken the calculation made by Mr. Giffen in the year 1883 of the incomes of the English people, the same being based upon previous tables of earlier date by Mr. Dudley Baxter and Mr. Leone Levi. Mr. Giffen states, in reference to this table, he is of opinion that a much larger figure may be taken; that the figures as to the incomes of the non-agricultural class give an average per head of very little more than is allowed for the agricultural labouring classes. It is well known that there is considerable difference in the earnings of the two classes, and Mr. Giffen gives his table based upon the previous calculations with this qualification. I therefore make an addition of 10 per cent. to the incomes of this class of workers. The result of comparison with the incomes of primary workers, as shown by the amount of primary production, shows the approximation indicated. The figures for incomes are £1314 millions, giving £657 millions secondary incomes, as compared with £658 millions for primary workers. At the same time there are about £30 millions of income on capital invested abroad, but to what extent it has stimulated and partly entered into the figures of production I cannot say. I have also dealt with the United States. In that country there has been no calculation of incomes, and I have therefore had to prepare an approximate computation. I do not put the table forward as an accurate statement of the incomes of the United States people, but only as an approximate computation. I have the Census Returns of all persons engaged in gainful occupations for the Census Year 1880, expressly distinguishing the manufacturing from the mechanical; and the Report of the Commissioners of the Labor Bureau, an exhaustive publication, gives the average earnings of all workers, male and female, other than the mental and administrative. I have a table from the details of the Census specifying all these latter workers. Their average earnings have been arrived at by reference to a compilation from the Census based upon the returns of the American railroads by a special agent, Mr. A. E. Sherman, employed in dealing with this portion

of the work. The railroads are considered as representing the average or general earnings of employés more than any other returns of the Census,—the employés including the highest paid officials and the lowest paid labourers. This estimate is one taken by Mr. Edward Atkinson in his computations, and I adopt it. Then I take the capital invested in railways, telegraphs, canals, shipping, residences, and business real estate, and estimate an average return on such invested capital at 5 per cent.; but not including the farms, of which all but a fractional portion are owned by the agriculturalists. I take the profits of manufacturers and traders on the amount of production at the same rate as in Australia, being given to understand that the rate of interest which prevails in the United States is about the same. And when I add up the figures given by such calculations on the data furnished by the records, I find that they give a total for all incomes double that of the production, to the extent of from one to one and a-half per cent. on the amount of the incomes—£2041 millions.

I have been able to verify my calculations for the Colony of New South Wales by another and an entirely different calculation, which gives precisely the same result. On page 334 of Mr. Coghlan's work "Wealth and Progress," for 1888–1889, in the chapter headed "Cost of Living," there is a table showing the expenditure of the population of New South Wales. I find upon enquiry that it was prepared for the year 1887, at a different time from that of the table of incomes, and from entirely different material. Necessarily so; because, whilst the production included in the other table as income consists in the greatest part of raw material at the point of production, the commodities upon which expenditure has taken place has been in imported goods of wholly different values at the point of consumption. Whilst the first table contains incomes received from wages employment, services, and Government expenditure, the second represents in great part the sale of products and payments, amongst other things for fuel and light, art and amusement, books and newspapers, household expenses, &c. I find, upon enquiry, that this table was also compiled from a vast amount of information outside the Statistician's office, as to cost of the different classes of the imported goods, selling prices, average profits, &c. The amount of this table is £48,700,000. When I add the portion of the absentee

incomes not expended in the country and Mr. Coghlan's estimated amount of savings, I find the amount to correspond with the table of incomes.

I have been able to verify the result shown by the figures as regards the Colony of New South Wales by the Statistics of a second period. My first calculation was for the year 1887,—a year of drought. Mr. Coghlan compiled the second table of incomes for the year 1889. This was a prosperous year, showing an increase of production to the amount of about five millions. Dealing with the figures of income and production given for this year in the same way that I dealt with the other figures, making the necessary deductions for the absentee incomes and loan money reaching the Colony, I find the balances to show incomes double the amount of the production; that is to say, the incomes of the primary workers having been increased approximately five millions, the incomes of the secondary workers were increased to an equivalent amount.

There is sufficient in these figures to indicate the operation of a law which is possibly a result of our present civilization. There are approximately the same results or observations in a number of countries representing entirely different conditions. It is not very material if it should be found that there is some divergence from these figures, so long as there is an approximation to the result indicated,—that of equal incomes by the two great classes of workers, or of corresponding incomes being given by the incomes earned in a country in the work of production. The difficulty of procuring exact statistics, variations which must necessarily occur from time to time, or occasional deviations, will not affect the general result. Statistical information is of an approximate character; but all our data, from the highest calculations, are more or less approximate.

In proceeding to trace, as far as it could be traced, the operation of this law or result, I find that the proportion of male workers in a country engaged in the work of primary production in the different countries indicates with great precision a close approximation to 50 per cent. For New South Wales for 1887, the year dealt with, the proportion is 49 per cent.; for 1880 it is 50·8. For the Census year 1881 it is 49 for New South Wales, 50·1 for Victoria, and for the whole of Australasia it is 49·4. The Census returns of the United States give 56 per cent.; but these figures must, no doubt, be taken with some modification. Out of 7,500,000

workers in agricultural industry for the Census year 1880, 3,300,000 are included as agricultural labourers. It appears that these figures include all the labourers engaged upon the farms; and some, including negroes, will, of course, be employed in other services than the actual work of production. For the United Kingdom the male workers in primary production cannot be ascertained from the data available. A table in the second edition of Mulhall's work gives the percentage of agriculture and manufactures at 45 per cent.: but these figures include female workers, who should not be included for ascertaining the requisite proportion of consumers; and, as the figures would be higher, according to those given by other countries, if females were omitted, there is the requisite approximation to 50 per cent. for male workers. The approximations deduced are sufficient for all practical purposes of a general result.

The hypothesis I have formed to account for the operation of the law is this: that as the workers at the centre of the circle, engaged in the work of primary production, approximately represent with women and children one-half of the population, they will actually consume one-half of the product, and that the other half of the product will pass to the secondary workers at the circumference in exchange for services. The incomes of the secondary workers come out of the incomes of the primary workers and out of one another, so much product representing purchasing power in the different hands through which it passes until it is consumed. Thus, a merchant receiving £3000 a year virtually receives the equivalent of product to that amount. He pays as rent £500 a year. Product to that amount, without his consuming any portion of it, virtually passes into the hands of the landlord. In like manner he gives incomes to those engaged in personal services, to professionals and others; and the amount he pays in the market-place in the purchase of clothing and of food for himself and family, or for the entertainment of friends, represents so much more of the product than its original cost; the difference being the incomes of the dealers and distributors through whose hands the product has passed. The larger incomes give off a number of smaller ones; the smaller ones give off incomes smaller still, until at length the product reaches hands where it is no longer given away for services, and is consumed. The only hypothesis I have been able to form as to the mode in which the secondary incomes duplicate is shown by this second diagram. It is a diagram

of Bastiat the French Economist, which he has called "The Circle of Universal Industry." I have taken from it my idea of the larger circle. The red lines and figures appearing in the diagram are additions I have made thereto. Bastiat places in the centre a producer A, who, he says, will represent production in general. He is a copyist, and produces four manuscripts which he supplies to consumers at the circumference of the circle. The art of printing is invented, and he is able to supply six copies within the time he was previously able to supply four; but competition reduces the price from 15 to 10, and he receives but 60, as before. "Who has gained by the change?" says Bastiat. "As regards value, no one." "As regards real wealth and positive satisfaction, the countless body of consumers ranged round the circumference. But the consumers are the human race. For observe that A himself, in so far as he is a consumer, gains exactly as others do. By turns A finds himself at the centre and at the circumference of universal industry; for he is by turn producer and consumer. Thus all profit by the progress of each, and each profits by the progress of all. This diagram indicates the equality which is involved in all exchange; but it does not deal with the total incomes or the question under consideration, as to how one-half of the product duplicates. Placing in this circle the figure 30, shown at the centre of the other diagram, one-half (15) passing to the circumference of the circle will be received as the incomes of numerous classes representing similarly to the classes at the centre, capitalists, middle classes, manual workers, and the lowest paid labourers. They will be hundreds of thousands or millions in a country; and in the general result it may be assumed that they likewise consume one-half of the product received,—passing one-half, say, to the circumference of another circle, in payment for services,—representing the incomes of other large and numerous classes. One-half of the product so received will be dealt with in like manner, and so on,—the total amount of the incomes becoming gradually smaller, until the product is so reduced that it gives off no further incomes: then, if these figures in series of arithmetical progression be added together, the result will be that the 15 passing to the circumference of the circle must duplicate. A calculation of this character as regards the incomes may, no doubt, be analysed; they may be the subject of classification, and the relation between the different kind of incomes

definitely ascertained. I think there can be very little doubt that this is the operation of the law. It is the only hypothesis which is possible to account for the equality of incomes between the two divisions of workers at the centre and the circumference.

It is a question for speculation whether the law, which is apparent, assuming it to be the outcome of civilisation, is only a stage in its development, or whether the same operation may be predicated in the future time; and it would be of interest to ascertain whether the law existed in past times, prior to the increased production which science and invention have secured, and, if so, to learn the period of its development. The question also arises whether there is the like result in European or other countries where the same proportion does not exist between the primary and secondary workers. I have given particulars as to some of the European countries in an Appendix. However it may be, the United States and England possess greater capital—the result of accumulated wealth—and have attained a greater supremacy in manufacturing industry, and there has, I believe, been no such improvement in the condition of the labouring classes in the European countries as that which has taken place in England or the United States during the last fifty years. If one-half of the secondary workers in any one of the countries for which I have given figures were transferred to the side of the primary, there would be an additional production to the amount of 50 per cent. It may be assumed that half of the additional product would go for services, and possibly duplicate,—still giving the remaining secondary workers equal incomes.

The law would not be indicated if the figures of production included that of an impoverished population owning small areas of land, of which the cultivation only yielded sufficient for their own bare requirements, with an insignificant outlay for anything beyond food. The incomes of such workers yield but in a very small degree secondary incomes in the expenditure which gives the higher civilisation.

The great problem is, how to give increased wealth to the largest number? The most obvious mode is to increase to the fullest extent all production which can be disposed of; and, so far as possible, in such a way that the wealth may be generally diffused. The application of the profit-sharing system, working regularly on a proper basis, would appear to be the mode by which this could be carried out as

regards the great staple-producing industries. The higher the remuneration which can be received by the manual workers, having regard to other conditions, the greater will be the measure of production in the centre of the circle. The surplus amount will, for the most part, be expended in procuring an increased supply of food, clothing, and other requirements. Every increase of production which can be disposed of will, as stated, give to the secondary workers additional incomes approximately to a corresponding amount to those earned by the primary workers; so that the increase of their earnings for a given number will primarily depend upon the incomes of the primary workers. Other obvious means for consideration in different countries will be measures of land reform, of fiscal policy, trade, and treaties with foreign countries, which will serve to promote or increase production.

One result to be deduced from the operation of the law which I have indicated, that the establishment of any productive industry will be of equal benefit to all classes, is that if, by a charge upon the total incomes, an additional production can be established, whether it be by way of bonus or under the protectionist system, if the whole of the workers within the circle of industry have to pay more for a particular commodity, say 10 per cent. on the production, or £100,000 in one million, they will, nevertheless, receive approximately an additional £2,000,000 of income, £1,000,000 being received by the primary workers from the increased production and £1,000,000 by the secondary workers.

The basis of all employment and incomes being the production of the land, one object of Government, which has not hitherto been recognised, should be to take such means as individual effort cannot accomplish to promote them to the fullest extent. The progress of production in a country has hitherto been left solely to individual effort. It should be the concern of Government, as all participate equally in the results; and it should be the object of Government, by any possible organisation and control which would not interfere unduly with individual effort, to prevent waste in the application of labour and capital, which must be to the detriment of all.

There is a phase in the industrial system of any country to which I have now to direct attention, and one immediately bearing on the problem in question. Let me suppose that the production of any country can be increased sufficiently

(as it can be easily increased in Australia) to absorb all the unemployed; that production can be set on foot under the profit-sharing system so as to give the industrious worker the fullest share in the products of work; that there are established in the country prosperous industries; that there are good wages and fair profits. Is it not evident that if there be an influx into this industrial circle of undesirable immigrants, that is to say, of immigrants who do not increase the production, but come to share in it; additional numbers of such workers in excess to compete in all the industries and employments with those who are here; if also, without increasing the numbers of suitable workers, there should be an influx of masses of capital to compete with and destroy capital in the particular industries already here, and also destroy itself and so lessen the production; if numbers of workers in the work of production and in the work of services should enter this circle far exceeding the demand, the wealth of the country may just remain the same, and be quoted proudly as before; the production will remain the same, and although this country might be the richest in the world in its mineral, agricultural, and pastoral wealth, in the midst of that wealth there would be bad times for the largest number? There may be the finest richest country, and the undue competition of numbers not employed in additional production would make times bad, and in the midst of plenty, which the country produced for adequate numbers, there would be the destitution which prevails in the older lands.

I am not advocating for one moment the restriction of suitable immigration. There is possibly room in Australia for millions where there are hundreds of thousands now; there should be room for millions more within the next few years, provided they are suitable workers, and that so far as there are numbers seeking employment they are accompanied by capitalists to give it. And if, when there has been established all the production which can be promoted in this or any other land, there should be surplus numbers unable to find employment, and the question is asked whether civilisation admits of their being provided for, the answer must be, that the more advanced the civilisation the greater the extent to which it does admit of provision being made for them. Under present conditions they may be provided for by the transfer of the surplus numbers and capital to other existing circles of industry where their services may be available, or by the formation of other circles; and future progress must

depend upon the ascertainment of the means and courses of action by which the same can be most readily and efficiently carried out. In England there is congestion both of capital and labour. Under suitable conditions, under some such conditions as I will presently refer to, this Australian circle of ours may become the very home of capital, and it may also become the homes of millions who cannot find employment, or suitable employment, in the English Isles. The idle capital, and the unemployed numbers it can so amply provide for, can be profitably and happily employed in other circles of industry in the foreign land or in the home land. Place a number of men within a circle of fairly productive country of an area in suitable proportion to numbers, organised so far that they are selected from the employments which admit of their carrying on agriculture and the lower branches of manufacturing work, and giving them but a limited exchange only with other countries, districts, or circles for some commodities which they do not produce, that community will, I apprehend, under co-operative conditions only, become self-supporting, and under more favourable conditions it will develop into a prosperous community. Such a necessary result is indicated by the success which has attended the beggar colonies of Holland and the labour colonies of Germany. The beggar colony of Frederiksoord, in Holland, is described by Herbert Mills as "a paradise in the middle of a wilderness." He tells us that he passed "from a dreary moorland, where the soil was too poor to grow heather or ling except in small patches, to a land laden with roses and violets, a contented, industrious peasantry, a long succession of compact fruitful farms, good roads shaded by trees, and excellent schools for the education of the young." "Perhaps," he says, "it was the effect of the sudden change, but I felt as if I had entered the gates of the promised land when I entered the domain at Frederiksoord. . . . . This place was established by private enterprise. . . . . Where the place now exists all was heath, and it was commenced with the settlement of a few poor families." There are other beggar colonies under the control of the Dutch Government where employment is provided for beggars and vagrants, subjected to the constraint of compulsory labour. They are described as enormous colonies both of agriculture and manufactures. Although these beggar colonies are not entirely self-supporting (full endeavours have not been made to make them so), their results—the success attending the labour colonies of Germany, which

appear to include every trade and profession, and to be all but self-supporting, and the success which has always attended English colonisation—are all evidences of a successful development attending a fair measure of assistance and control in the direction indicated.

The extent to which the elements of civilisation would exist in any new circle which may be formed will necessarily depend greatly upon the amount of capital which is available for the employment of the workers. A pauper population may be provided for by inner circles of co-operative industry not interfering with the economy of the larger circle. In other circles of industry there must be pioneers of civilisation, as there have been, and are now, in this Australian land: men and women to carry with them into the primitive forests and on to the wide plains—destined, necessarily destined, to support the population of the earth—the elements of civilisation, and to found or extend those new communities spoken of by Henry George, and referred to in the commencement of this paper, "where Anglo-Saxon vigour begins the race of progress . . . where there is no luxury, but there is no destitution, and everyone can make a living." Men and women can be pioneers of civilisation, and to a great extent carry it with them. It is not merely the wealthy who realise its full results; on the contrary, those who have accumulated wealth are often the least able to realise and appreciate the blessings which civilisation brings. By far the largest number pass their lives dependents, yet participating in and enjoying those blessings. Men have to work for ease and luxury. The surrounding conditions of life may give to some easier means of obtaining them than to others; but the education and culture of civilisation can be carried into the primitive land, and redeem it. The companionship of others will, for the most part, be forthcoming; the printing press gives all the wealth of knowledge, science, and literature; and existing means of locomotion diffuse it through the length and breadth of every land which becomes the subject of English settlement. The highest results of civilisation, the full measure of life's conveniences, are not realised by such pioneers; but, as compensation, there are the blessings of a more extended freedom—freedom from want and care; independence of thought and character; a high resolve to make life's work good and useful, and to achieve to the utmost what each may have power to do. Such work is undertaken voluntarily by tens of thousands

of the best and bravest natures—by many able to command all the luxuries and refinements of civilised life. It should be for Government in every country and part of its organisation to provide for these new circles of industry, both in a foreign land and in their own. Such a course of action must be the outcome and ultimate result of civilisation. As it progresses the tendency is for wars to cease. The amounts now expended by the older countries in war material and the maintenance of standing armies would be alone sufficient to establish new settlements, whose requirements must increase the industry of the parent land. Had the English capital which has found its way to the South American Republics, which has fed their workers, constructed their public works, and developed their industries, been invested in English settlements, it would not only have been more secure, but would have placed English trade on a better footing, and have increased England's strength.

One great cause producing the results stated by Henry George is that numbers too large are for evident reasons found at the most attractive centres seeking to participate in the results of the most developed civilisation. Those results being dependent upon human effort are necessarily circumscribed by its potentialities, and no matter what those potentialities may be, inasmuch as they are not infinite, the claims and demands upon them can be exceeded; and the greater the conditions of prosperity offered by any country, city, or centre in which there may be the barest possibility to share, the more the pressure of numbers in excess will make itself felt, in the absence of restraining influences. Herbert Spencer remarks that "Socially, as well as individually, organisation is indispensable to growth; beyond a certain point there can be no further growth without further organisation." There is no remedy—in the very nature of things there never can be a remedy—unless by means of some organisation or control, which our civilisation has not yet reached, and of which our systems have not yet recognised the necessity, restraint can be imposed upon the undue pressure of numbers at any given point; unless there could be an organisation which, whilst leaving freedom of action as to general employment, and not interfering with the just rewards which should appertain to the most successful efforts of intelligence and skill, should nevertheless close avenues of employment overcrowded with workers to both employers and employed, so as to avoid waste of labour and capital, and

to direct their application into channels where they may find profitable employment to the benefit of all,—an organisation which should aid, either permanently or for a time, those who cannot find employments suited to their capabilities within the circle of industry where civilisation cannot provide for further numbers, and which should remove the idle and the depraved from the most developed centres of civilisation to which they now gravitate from all parts of every country or continent to live or prey upon its strength, and compel them, whilst means of employment are wanting, to support themselves in a circle of co-operative industry,—an organisation which will recognise the necessity of the restriction which the United States Republic is now forced, in self preservation, to impose upon undesirable immigrants. One of the objects of government in every large country under present conditions should, and must ultimately be such organisation, to secure the direction and restraint contended for, and provide the minimum of capital to admit of the formation of new circles of industry where the unfortunate, instead of becoming the Huns and Vandals of civilisation, may become the promoters of its progress.

In dealing with the industrial system the public mind of Australia has not yet grasped a vital question which must, I consider, become the question of our time—the results and the control of unrestrained and indiscriminate competition, not merely from the point of view from which the unions of labour regard it, but its results generally to a community, more particularly as indicated on the American continent. Whilst in Australia the trades unions have been dealing with the question of unrestricted competition in the ranks of labour, in America it has received the special attention of capital. It has been found there that the employment of large capitals and extensive machinery have been crushing the small industries or compelling them to unite together. Hobson states that the force of competition makes the struggle for existence among the small businesses keen and hopeless; and it has been lately calculated in America that 95 per cent. of those who enter business fail of success. We see the further operation of the system extended to the competition of the associated capitals, the struggle between the big survivors becomes more intense, and ultimately trusts absorb the whole of the different industries, the businesses coalesce and unite in forming one great joint stock company. He states that "more than one-third of the United States

business is controlled by trusts ; that everywhere this process is at work. Competing firms in every trade, where their small numbers admit, are striving to come to closer terms than formerly, and either secretly or openly joining forces so as to get full control over the production or distribution of some product in order to manipulate prices for their own profit." It is contended, he points out, that the trust "is a natural step in the evolution of capital, that it belongs to the industrial progress of the day, that it is distinctly an effort to induce order into chaos, to save the waste of war and to organise industry ;" but he remarks that "if a single trust rules the market there will be no force to secure to the public any share in the advantage." A review of the whole system must lead to the conclusion that the result cannot be for the benefit of the manual workers or the general body of consumers.

Considering unrestricted competition, as regards labour, from the point of view in which I am regarding it, the miserable condition of large numbers of the labouring classes in the United Kingdom is found to be the greatest in the occupations in which the employment is the lowest ; its worst effects are among the ranks of unskilled labour. The cause of excessive supply is attributed to the influx of the rural population into the towns, and the steady flow into the country of cheap unskilled foreign labour. It cannot be denied that if the population of every country is allowed to increase by foreign immigration beyond the limit which its industries can maintain, that want of employment must prevail, and that in time there will be large numbers for whom the general circle of the industrial system in that country cannot provide.

The following passages from Hobson's work illustrate exactly, not only the present but that which must be the future progress of thought in the Australian land :—

"There can be little doubt that if a few shiploads of Chinese labourers were emptied into the wharves of East London, whatever Government chanced to be in power would be compelled to adopt immediate measures of restraint on immigration, so terrible would be the effect upon the low-class European labourers in our midst. . . . It is not improbable that if the organisation of the workers proceeds along the present lines, when they come to realise their ability to use political power for securing their industrial position, they will decide that it will be advisable to limit the

supply of labour by excluding foreigners. Those, however, who are already prepared to adopt that step, do not always recognise, as clearly as they should, that the exclusion of cheap foreigners from our labour market will always be accompanied by the exclusion from our market of the cheap goods made by those foreigners in their own country, the admission of which, whilst it increases the aggregate wealth of England, inflicts a direct injury upon those particular workers, the demand for whose labour is diminished by the introduction of foreign goods which can undersell them. If an alien law is passed it will bring both logically and historically in its wake such protective measures as will constitute a reversal of our present free-trade policy. . . . It seems not unlikely that a democratic Government will some day decide that such artificial prohibition of foreign labour, and the foreign goods which compete with the goods produced by low-skilled English labour, will benefit the low-skilled workers, in their capacity of wage-earners, more than the consequent rise in prices will injure them in their capacity as consumers."

I believe that the organisation contended for may be established with facility in a young country like Australia by a system of industrial licenses. The first step is to prevent the conflict of capital with capital, so far as it is possible, in industries to which the system can be fairly applied. I do not contend that the system could be applied to every industry, or brought into operation all at once. Any capital destroyed in a country is detrimental to the whole community,—it is not merely the loss to the capitalist. Instead of allowing capitals to destroy each other, or to form great trusts so far free from competition as to admit of their imposing higher prices upon the public, and realising enormous profits, and so that the product does not receive any equable distribution among the producers, the amount of capital employed in particular industries might approximately be restricted to that actually required, and no more. The monopoly conferred by the license would bring capital to Australia which does not come now, and admit of conditions being imposed. The system would not do away with competition—it would have full operation in the first instance as to the terms upon which the capital should be invested. If, under a protectionist system iron industries could be fully established in Australia, and the production of iron to supply the Australian continent would not for some time exceed approximately five

millions per annum, so many smelting works being required, so many rolling mills, and so on, requiring capital approximately to the amount of ten millions for the erection of the plant and factories, tenders could be invited from the world for the different industries, as to the minimum rate of profit which the owners of capital would be willing to accept for a period of time. For the employment of such capital, and for production not exceeding a stated amount, monopolies might be given by means of the licenses at the minimum rate of profit. Being assured against undue competition, capitalists would be willing to accept a lower rate of profit. We know that capital is content with as low a rate as 3 per cent. where absolutely secured. In industrial enterprise a lower rate would be accepted under the system than would be otherwise required. The tenders would be invited upon the terms of paying a fixed minimum rate of wages,—a rate which would be determined upon by arrangement with the unions. If the rate were fixed too high, the capital would not come. Let the working day be eight hours; and the profit exceeding the minimum rate, after providing for necessary contingencies, be divided between the employers and the wage-earners, in proportions to be determined upon. The industrial licenses once granted to the employers for a period of time, the industrial licenses issued io the workers would fix the rate of wages as one of the conditions of the licenses. Other conditions would be determined upon as far as possible, and it should be compulsory to refer all differences to arbitration. A strike should, *ipso facto*, result in the determination and absolute loss to the strikers of the licenses,—this result being unalterable, by legislation of a constitutional character, to which I will presently refer. It would not be compulsory for either employers or workers to continue work: either of the parties could discontinue—there would be a termination of the licenses, and that is all. The profit-sharing system would be the means of increasing production. It may be the case that it has not always been successful; but it is said to have been attended with the most advantageous results in France, and with the industries established on an increased footing of stability the full limits of profit would be secured. This would be giving capital engaged in industrial enterprise a measure of security which economists have not yet devised. If it were once established that means had been adopted to guard against strikes and to prevent the loss arising from undue competition, if the system worked harmoniously, then

Australia would become the home of capital; it would flow to the continent for every industry in which it could be profitably employed.

The next phase in the operation of the system would be to prevent the undue competition between the workers. Restrict the industrial licenses as far as possible to the numbers who can be profitably employed in the particular industries. When the systems were first brought into operation licenses would be issued to all engaged in the particular industries, or to all who had been so engaged within a limited period of time previously; not to new-comers, possibly flocking to the place to take advantage of the system. If there were a larger number than could be employed, then some time must elapse before the numbers were absorbed and the system came into full operation. There would always be some unemployed—work, of course, varies throughout the year. My contention is, that if a particular industry can only employ say 5000 men, with possibly a further number of 500 or 1000 behind them unemployed, it is useless to allow others to compete in that industry; it is to the injury not only of the workers but to all others in the community. If there are 1000 male workers idle, reckoning the rate of wages at £3 weekly, there is a loss of income of £150,000 a year, and the secondary incomes being approximately the same, there would be incomes lost to the people of, approximately, £300,000.

If workers were required beyond the number licensed for the time being they would always be available. Employers requiring particular descriptions of labour would apply to the Bureau of Labour if there were no unemployed, and additional licenses would be issued for the particular employment, either absolutely or for a limited period of time. They would be issued in the first instance to those registered for the particular employment when licenses were available, probably working at other industries. The unemployed in particular industries would obtain temporary licenses for other employment of a kindred or other character. The iron-worker in one branch of the industry would find employment for the time being in another.

In time there would not be material numbers of unemployed in the particular industries—the system would prevent the influx of foreign workers beyond the number required. It would be in Australia as in every other country, it would be the unskilled labour in which there would be the material surplus. When all of those who could be employed had

found employment in the cities, the others would have to accept licenses for the country districts; when all who could be employed in the country districts had been provided for, licenses would be available at lower rates for taking up new Australian lands, such workers having a prior right to licenses for the more remunerative employment. This would operate in two ways. It would settle throughout the country numbers of unemployed and the latest arrivals who now remain in the towns, and it would send to the rougher work the men most incompetent for the other employments. The industrial license would be to some extent a certificate of competency. The system as contemplated would be to secure the thorough and complete co-operation of the competent and better class of workmen. The worker who could not in the first instance find employment in the city would be content to take the country work for a time. The industrial and temperate would in time be recognised as having a prior right to the better class of licenses. Those who were only fitted for the rougher work would find their places.

The system in this respect would secure the employment of capital and work for unemployed which would not otherwise be forthcoming. Wherever profit can be made after paying wages at a definite rate, capital will, as a rule, be available for its employment. There is work which could be carried on in the country at a lower rate of wages than that which prevails in other employments. The wool-producing industry is possibly the most profitable in Australia, and the highest wages earned in the country are at shearing. Higher wages can be paid in the manufacturing industries than are paid to a farm labourer. If, after all have found employment, capital should be forthcoming to take up new lands, to open new mines, or to clear lands already taken up at lower rates, and there are numbers unemployed, the unemployed must accept the lower rate of pay, at least until better wages are procurable. Employment might be found in this way without reducing the current rate of wages in other employments.

By means of this system the vexed question of freedom of contract would be solved; the undue competition which is the basis of all the disadvantages with which labour has had to contend, and which the unions have been only partly able to remedy, would be absolutely at an end.

One objection will be forthcoming by employers to this system. It will be said power is always liable to be abused, and the workmen, whose numbers will be limited in the par-

ticular employments, will be able to do as they please. At the present time there is the check which the free labour gives. Under this system there will be no free labour. The objection would not be tenable, dealing with the question from the employers' point of view, and for the sake of argument, without regard to the interests of the labourer, the employer would be in a far better position. Under the system proposed the employer could not bring foreign labour to the country to supplant the industry of the home worker whilst the licenses continued. If a strike took place, the result would be that the licenses of the home workers, securing to them a permanency of employment or right to prior employment so long as a strike did not take place, would be gone, and the employer at liberty to secure other workers for whom licenses would be available. During the late strike in New South Wales there were no proper or skilled wharf labourers. During the late strike in Queensland there were no skilled shearers, but the demand for substitutes was supplied, although inefficiently, from other quarters. If the strike had been that of bootmakers, engineers, or other skilled artificers, it would have been different. It would be just the same under the proposed conditions. I am assuming in the system I have indicated the co-operation of the representatives of labour. No system can ultimately secure industrial peace unless it receives the assent of all classes in the community—all uniting to perfect and promote it. I am assuming that under the system the true relations between capital and labour will be better understood, and that views will prevail far removed from the antagonism of the past.

The principle underlying the system proposed is already recognised in Australian legislation to a far greater extent than I am contending for. The richest lands are granted in perpetuity at a sum far below their market or prospective value in consideration of *bonâ fide* settlement and improvements. Mineral lands have, in like manner, been granted in fee in consideration of a definite expenditure, or upon lease at a nominal rent under the condition of employing workers. The richest gold mining claims may be taken up and held indefinitely under an annual license costing ten shillings for each man in consideration of the conditions of work. Disputes are efficiently dealt with by wardens, and exemption from work is granted for necessary contingencies. In Victoria the tram lines are a concession in consideration

of their construction, and in other countries there are similar concessions for railways and public works. Public vehicles are licensed, and the proprietors subjected to conditions. Competition and conflict with the unions led to the liquidation of the Australian Steam Navigation Company of New South Wales, possessing the finest fleet of steamships in the Southern Hemisphere. The monopoly of a wharf, conferred upon the Port Jackson Steamship Company, has been the means of establishing a service of the fullest efficiency, which did not exist before, at lowest voluntary rates of charge. The operation of the trust to prevent the waste of labour and capital by excessive competition, the endeavours of the Australian unions of labour to limit their numbers, and their present antagonism to the employment of free labour outside the unions, represent the action of organisations based on the same principle, but in the interests of particular classes, without being subjected to any conditions to secure the interests of other classes.

The morning on which I post this paper to the Secretary of the Section gives a cablegram in the Australian newspapers notifying that Count Caprivi, the German Chancellor, has proposed to introduce a Bill in the Reichstag to prevent agricultural labourers flocking from the country into the towns.

There should be in every land a Department of Industry to concern itself with the industries of the country and the employment of its people. For production to realise its due results, to bring to the workers the full measure of the incomes it should give, it must receive all the assistance to be derived from the progress of knowledge and invention. A Department of Industry in a new country like Australia should be a permanent exhibition of industry; it should contain within its walls models and machines of the latest construction; it should be able to give information as to the most approved processes, and the best methods of work. Its objects should be to collect information as to the employments of capital and labour; to direct their operations by means of industrial licenses; to regulate the numbers who could fairly find employment in the particular industries; to impose such conditions as to the use of the most approved appliances, and the adoption of the profit-sharing system, as to secure the fullest amount of production with the most equable distribution of its wealth; to obtain and impart all information which could be of service to the industries of the

land, having its agents in foreign parts, and sending its messengers throughout the country to obtain and give information; to assist as far as possible by its agents in opening up markets in foreign lands; and by means of a deliberative body, to aid as far as possible in all these efforts. To carry out such an organisation such a department should be under the control of men entirely free from political influences. The electors should be represented by the different classes engaged in gainful occupations, or divisions of those classes. Employers of labour in manufacturing industries would be one class or division; merchants and those engaged in importing and exporting goods should be another; wholesale warehousemen and wholesale dealers another class; retail shopkeepers and dealers, the owners of realised wealth, manual workers in manufacturing industries, in mining industry, those engaged in personal service, &c. should all be separate classes. The officials of the Department should be those chosen by the majority of the classes for a limited time. They would be the men most trusted in the community, most distinguished for ability and integrity. They might or they might not be eligible for re-election. Once elected for a term they should be subject to no interference or political influence. The constitution of the country would provide that the law of the industrial system should be unalterable to the detriment of any contract entered into, and that any alteration therein should take place only after efficient constitutional checks.

What is to be the ultimate result of the present antagonism between labour and capital?—of the existence of constantly increasing numbers of unemployed in every large country? of the progress of socialistic thought?—of the desire for change and the reconstruction of society? How are the contending and opposing forces, whose joint efforts are so essentially required for the work of progress, to become reconciled?—by what means can they be made to work harmoniously together? —how are the rocks ahead to be avoided?—except by some such organisation of the industrial system as that which I have suggested. The existence of large numbers in each country unable to find employment, must be recognised as a fact society has to deal with—to be dealt with indiscriminately, or by the State. The obligation of the State to concern itself with the question is, I believe, the opinion of the vast majority, and one which it will insist upon. If the operations of capital in the formation of trusts, which absolutely control production

and prices, are carried to a successful result, the same must induce resistance. There is already conflict between employers and the unions of labour, which shows no sign of temination. The organisation of industry which I propose, whilst putting an end to the results of unrestricted competition on the one hand, and the tyranny either of combinations of capital or labour on the other, would tend to harmonise conflicting interests, and would leave free the individualism which now exists. I do not presume to present a perfect system, but one only for development. Any objections which may be urged against it should be weighed against the deficiencies of present conditions. There is too much tendency in a new country like Australia to follow old methods of procedure, notwithstanding that they are inefficient, or a partial failure to secure the ends in view.

I have found it difficult to deal within the limits of a paper for our meeting with a subject so comprehensive as that which I have undertaken; and any views which I have stated, if meeting with approval, must be regarded as embodying merely the statement of thought and problem for amplification.

A recapitulation may assist discussion.

I commence with the problem of poverty in the large centres of civilisation and the means which are there found wanting to provide large numbers with employment, or to supply the wants which civilisation renders more and more necessities of life; the tendency towards socialistic thought, and the urgent need for action of some kind to meet present deficiencies.

I have raised the question whether such deficiencies may not be due to the failure of economic science to indicate definitely the means which shall control present elements of conflict.

For such purpose I have endeavoured to trace the operation of the industrial system, and submit that there are indications of a law or result establishing that the production of a country, which is disposed of, in addition to the incomes received by those employed in the producing industries and expended in the country, gives approximately corresponding incomes to all other classes, so that such production of every kind must be of benefit to all.

I state the general conclusion as to this result—the necessity and the obvious means of increasing production to the fullest extent so as to give increased incomes for larger

numbers; and I contend that one object of government, which has not hitherto been recognised, should be to take such means as individual effort cannot accomplish to promote to the fullest extent the progress of production in a country, and prevent waste in the application of labour and capital.

By reference to a circle of industry, I endeavour to realise fully the evident truth that if there should be an influx into such circle of workers in excess without increase of suitable production, or influx of additional capital beyond requirements in any particular industry, that the evils and dangers which attend civilisation in the older countries must exist.

I have taken the view that the natural, the only, and the necessary means to provide for surplus numbers is to be found in new circles of industry, either under co-operative conditions within the larger circle, or by transfer to other existing circles, such as the Australian circle of industry, or in new circles in a foreign land, where men and women may become the pioneers of civilisation; and I contend that it must be for the government of every country and part of its organisation to provide those means.

I have pointed to the numbers in excess who throng the most attractive centres, seeking to participate in the result of the most developed civilisation, and I have put forward for consideration what must, I conceive, be recognised as a fundamental truth, indicated by Herbert Spencer, that "socially, as well as individually, organisation is indispensable to growth, and that beyond a certain point there cannot be further growth without further organisation." I contend that there is no remedy—that in the very nature of things there never can be a remedy—unless there should be some organisation or control which our systems have not yet recognised. I contend that an attempt should be made to initiate an organisation to meet the requirements indicated in Australia, so that it may develop with the growth of large industries not yet commenced, or in the infancy of progress. I propose such organisation by means of industrial licenses to the workers, and also to the owners of capital, so that the concession or monopoly for a time may secure its employment on the continent, and so as to impose the condition of the profit-sharing system on a regular and systematic basis, and by such means to increase production and terminate the unhappy conflicts between employers and employed.

And to carry out these objects I advocate the establishment in every country of a Department of Industry under

the control of independent officials, with a constitution sufficiently rigid to prevent the exercise of political influence.

I believe that by some such means there may be a great future for this Australian land—that here we may find the amendment and reformation of political and social institutions which other countries have been unable to accomplish. We have the experience of the past to guide us; we stand here in the foremost rank of progress; it is not for us to be satisfied with the same achievements as the people of other countries; it is not for us to rest content with what they have done—we must do better to do well. If we can partially overcome the sphinx riddle, which not to answer is to be destroyed, if we can ameliorate conditions, harmonise employments, redress grievous wrong, should we be hindered by the unsolved problems of overcrowded continents? We possess a land bright and beautiful, endowed with all the blessings which heaven bestows, a land of gold in its mineral wealth, rich in those great primary factors of production, the iron and the coal,—rich in the pastures and land, which give the choicest of wool and the finest of wheat. We possess a genial climate, in which men can breathe more freely than under the heavy clouds of northern skies. The race of the aboriginal has been run on our continent, the ocean depths protect it against the aggressions of war, and it is free from any embittered memories of civil strife. Here it may be possible within the immediate future for larger numbers to better conditions more successfully than in any country under the sun; here labour and capital may join hand in hand in the proud work of Anglo-Saxon progress for the attainment, under a more advanced development, of its higher and its greater results.

Appendix.

Particulars of Industry in European Countries.

The following particulars are mainly extracts from Mulhall's works:—

In France the primary workers are 75 per cent. Of the agricultural class, or, to be strictly correct, of the landowners amongst whom the class are found, there are 1,134,000 landowners exempted from taxation on the plea of being paupers. 1,816,000, holding lands of an average under six acres, are just able to make a living, but constantly tending downwards by subdivision to the cottier class; and the cottiers, about

1,500,000, owning barely an acre each, support their families by the wages they earn as day labourers. He states more and more the subdivision of the land has already begun to bring about its own remedy, the agricultural population having diminished 3,500,000 since 1851. This decline is in a measure due to the introduction of machinery, in which respect wonderful progress has been made in our time. Forty years ago it was not uncommon to see horses treading out grain as we used to do in England in the days of King John.

In Germany agriculture is most advanced in those States where the average size of the farms is not below 40 acres. There is, unhappily, a large number of cottier farms, as in France, so small and confused that it sometimes happens a man ploughs his neighbour's patch for his own. The condition of the rural population is, on the whole, very prosperous; but the German can neither raise so much grain nor show the same results for the labour of the individual as in the United Kingdom.

In Austria the feudal system was only abolished in 1849, and in some of the provinces the land belongs for the most part to the peasant proprietors.

Italy has only recently entered upon an industrial progress similar to that of other countries only within the last thirty years, and the land is not as well cultivated.

In Russia 86 per cent. are on the side of the primary workers and only 14 on the other, and of the 86, 81 per cent. are agricultural; but then, as Mulhall tells us, previous to 1861, 80 per cent. of the population were serfs, who were bought and sold on the estates like cattle. Since the emancipation they are hopelessly plunged in debt. Many of the peasants are poorer than before, and their stock and cattle show a falling off of 50 per cent. in the last ten years.

3.—THE EFFECTS OF PROTECTION ON THE IMPORTS OF AUSTRALIA.

By ALEXANDER SUTHERLAND, M.A.

The object of Protection is to cause work to be done in the colony that would otherwise be done outside of it. The idea is that if £20,000,000 worth of articles are imported from abroad then the workers of this country are debarred to that

extent, or to some portion of it, from the remunerative employment which they might otherwise have obtained. Except with trifling exceptions, all value is the result of human labour; and when these goods to the value of £20,000,000 reach this colony they represent the expenditure of that value in labour, and we in this colony are very properly regarded as having helped to feed and clothe and house a large army of people abroad by giving them thus of our custom for their labour.

Hence arises the benevolent and patriotic desire of rather giving this employment to our own people; of housing and feeding and clothing our fellow-colonists, who are so much nearer to us and whose necessities ought to be so much the more a care to us. And with that laudable feeling I have every sympathy, though I believe that it is and must remain a futile one. For nature has placed barriers of her own against its operation to any useful purpose. This has been shown as the result of theoretic enquiry over and over again; but in this paper I propose to put it to the test of an actual appeal to facts.

Does our protective tariff in Victoria diminish the amount we import of the results of foreign labour? Look at the diagram herein enclosed. Let us call the broad line running across the middle with dates upon it the "base line." The dates run from 1838 to 1890. A line measured up from the base line at any year represents the amount per head of the imports for that year, at the rate of an eighth of an inch for every £ per head of the imports. Points being thus got for every year from 1838 to 1890 these points are joined to make the continuous line, which thus becomes a sort of picture of the imports which the eye readily takes in at a glance. Here we see that when the people first began to come to this colony they had to rely for everything on the foreign producer. They had no factories at work. They had not even the soil broken up to grow their own corn or their own vegetables. In 1840 the rate of importation reached its maximum. The colony began to produce for itself. The imports, which had been as high as £40 per head, declined to only £7. And so it continued with little variation till 1850, when an immense influx of men took place, and all busied themselves in getting gold, while hardly any of them thought of producing the articles which were necessary for their consumption.

The natural result is clearly shown in the line of imports which suddenly runs up beyond all bounds, till it reaches its

topmost point in 1853, and begins to turn down again under the influence of two causes; first, the cessation of wild consignments on speculation from England; second, and more important, the cultivation of the land by the community, which began to produce its own food-stuffs. Thus the line of imports continues steadily to decline, till the year 1865, when the first protective duty of ten per cent. was imposed. The natural result of such an impost would be to send up the line of imports for a time, as importers hastened to lay in their stocks before the duty would become payable; and so we find the line takes a sharp turn upwards. Of course when trade returns to its ordinary channels this will be compensated to some extent by a sharp decline whilst the importers are working off the heavy stocks they have laid in. That this took place is evident on inspection.

What we should then naturally expect to see, would be a permanent lowering of the line as the effect of the imposition of a protective duty, But we see no such thing. After a temporary turn downwards, the line rises to its normal height. Then in 1871 there is an increase of protective duties, which thereafter stand at an average of 15 per cent. This shows no effect whatever. For two years afterwards the line of imports rises with the most complete indifference to protective imposts; and having reached a comparatively high level it stays there. Nor does the imposition of duties of 20 per cent. in 1874 show any decline of such a character that it can be attributed to their influence. The increase of the duties to 25 per cent. in 1880 shows no tendency to bring down the line of imports. Whatever trifling decline there had been before is now made good in the two years immediately following the imposition of the higher duties. Since that date the duties have been steadily rising, and one would have expected as a consequence that the line of imports would have fallen. No such result, however, is visible. The line of imports goes on with the most provoking calmness, paying no heed to the vain schemes of men.

A twenty-five years' retrospect therefore shows that our protective duties have not diminished the amount of our imports, and therefore that they have failed of their primary purpose. But in using any such sets of figures we must exercise great care in seeing that our conclusions are justifiable. It might easily be the case, for instance, that the amount of our imports had a natural tendency to increase as the prosperity of the community augmented, and that our protective

duties had done good work in keeping down that natural increase. It is not difficult to show that this has not been the case, but the readiest and best answer will again be a pictorial one. Look at the chart of the imports of New South Wales, drawn up under the same system. There are no protective duties there, and yet the line of imports shows no tendency to a steady rise. It has its ups and downs as one would certainly expect; but on the average it does not differ in any notable way either in height or in variations from the line of imports for Victoria.

Another doubt may occur in this way, and that very reasonably. It may be urged that although the total of imports has not been affected, yet the incidence of our importation may be radically altered. And to a very decided extent that is true; not so much by a good deal as protectionists are inclined to believe, and yet sufficient to show some tangible effect of protection. What the net result of that change has been would be a most intricate question to solve; but though it is a most important one, it is quite beyond the resources of political economy in its present inexact conditions to solve the problem.

But it is not unfair to insist that the question should be treated in its broad and simple outlines; and from that point of view it is perfectly safe to say that our protective duties have not shut out the products of foreign labour. We now import foreign products to the extent of about twenty millions' worth per annum; that is perhaps the equivalent of the labour of some quarter of a million of men for a year. That is to say, we provide employment for that number of men in other lands. The great idea that underlies the theory of protection is that the employment should be in whole or in part taken from these people and transferred to people who live within our own borders. The table herein enclosed shows that if this was the object proposed, the theory has clearly failed when reduced to practice.

I am not one of those who think that protection exercises a very great or very ruinous effect upon a community. To me it seems to be only a little more than a question of the incidence of taxation. But whatever small influence it actually has seems to me to offer only a few advantages, but a much larger number of disadvantages.

This, however, is beside the present question. Confining our attention to the point in hand, I am convinced that protective duties have been entirely inoperative in regard to the

primary motive for which they were established. While I remember with sufficient vividness that in no science have so many hasty generalisations, so many unwarrantable conclusions, been made as in political economy, yet I feel it safe to assert that a careful examination of the figures of the Australian Colonies will show that in no one case has the imposition of protective duties resulted in a decline of imports. And this is equivalent to the statement that our systems of protection have been in practice nothing but failures.

4.—IS CAPITAL THE RESULT OF ABSTINENCE?

By A. J. OGILVY.

The proposition that Capital is the result of abstinence is generally considered by economists so self-evident as to require no proof. They therefore simply state it, give an illustration or two of what they mean, and pass on.

I venture to submit that this proposition has been taken for granted far too easily,—that Capital has not originated solely or chiefly through abstinence, and, in fact, that abstinence has had very little to do with the matter.

Let us make sure, first, that we understand the real meaning of the proposition, and are not disputing about mere words.

1. As to the term "Capital." There have been many definitions of it given by economists, and no two are agreed as to the proper definition, while the man of business understands by it something quite different from any of them, viz., money, or the command of it.

But we need not concern ourselves about these differences, for they will not affect the issue I propose to raise.

A factory with its looms and engines is wealth devoted to production, and is therefore capital in the technical sense, if anything is; while a private mansion, with its picture galleries and costly furniture, is wealth devoted to enjoyment, and therefore technically *not* capital.

But the proposition before us, if it is true of the one is equally true of the other. If self-denying abstinence was required to produce or to maintain the factory, it must have been equally necessary to produce or to maintain the mansion. The proposition applies to all accumulated forms of wealth alike, or it applies to none.

What it really amounts to, then, and what was really intended, is that *accumulations* are the result of abstinence; and I shall therefore henceforth so express it, dropping the word "capital" altogether as expressing a needless limitation, and sure to give rise to irrelevant discussions as to its nature.

2. As to "Abstinence." Difficulties have been suggested to me as to the meaning of the term "Abstinence;" but these difficulties are not raised until it is found that if the term is used in any ordinarily accepted sense, the proposition in question falls to the ground, and therefore the term has to be used in some mystical or figurative or technical sense, as to the exact nature of which no one seems to feel very certain.

But the proposition that Capital (or, as I now put it, Accumulation) is the result of Abstinence is put forward by Mill and the economists as a self-evident truth needing no demonstration, which implies that its terms are to be understood in the ordinary sense; for how can a proposition be self-evident if its terms are mystical or technical, and the mystical or technical meaning is not set forth?

The term may of course be made to mean anything. A man who does anything may be said to abstain from not doing it, but this is to expand away its meaning altogether, for a word that means everything means nothing. The word, I take it, is here meant in its ordinary every-day sense as implying prudence and self-denial. Indeed, the words "prudential" and "self-denying" are often expressly introduced, and capital is said to be "the reward of self-denial," which, as I have shown, if it is true of accumulations devoted to production is equally true of accumulations devoted to enjoyment.

What we are to understand, then, by the proposition before us is that any given product of the past continues to exist in the present, because some one self-denyingly abstained from consuming it (from actually using up and destroying it), or else self-denyingly refrained from consuming something else which was necessary to produce this.

I do not, of course, say that accumulations are *never* due to self-denying abstinence of this sort, but my contention is that such cases are few and insignificant in comparison with the mass; and that, speaking broadly, accumulations are due, not to abstinence, but to a variety of causes, the three chief of which are—

1. To extra exertion: that is, a man having satisfied his immediate wants, proceeds to produce something else which he does not want now, but expects to want hereafter.
2. To the natural durability of most of the articles we produce, in consequence of which they are produced faster than they are worn out, and so accumulate.
3. To the exercise of ingenuity and advance of knowledge, whereby with the same labour that we formerly produced a mere sufficiency we can now produce a surplus.

There are other causes, no doubt, but these will suffice for our purpose.

We shall begin our illustrations with the stock example usually given by economists, that of a tribe that lives by fishing. The idea of the economist is that the Indian, having caught his supply of fish, self-denyingly abstains from consuming as much as he would like in order to put some by, and so accumulation originates.

My idea is that no self-denying abstinence comes in anywhere. The Indian when he goes out fishing catches one or another of three given quantities of fish. Either he catches less than he can comfortably consume, or exactly as much as he can comfortably consume, or more than he can comfortably consume. If less, he can hardly save even if he wants to: he must eat all he has caught and still go hungry. If he catches exactly as much as he can consume, then indeed he might save by putting himself on short commons, but he certainly won't, because it is not in his nature to do so, and because it is not necessary.

The Red Indian, when he has killed his game, eats as much as he can, then if there is any left over he saves it, but not otherwise. His supplies of food are laid up at great harvests of special exertion, at the buffalo hunt or the spawning season of the salmon, on which occasions he does not practice any abstinence but quite the contrary, but undergoes unusual and prolonged exertion.

There is one occasion on which the savage may be expected to use prudential abstinence, and that is in presence of some great impending crisis. In Kamstchatka and other subpolar regions the ground in winter is covered many feet deep with snow, the wild animals have either migrated or are hibernating, and there are no wild fruits to be got. In such

case the tribe would perish but for a previously accumulated store of provisions; so, as a matter of simple self-preservation, they must save. But in such case they only save enough just to tide over the crisis, and barely enough for that. By the time summer comes round again the whole tribe is generally in a state of semi-starvation. So serious a matter did the Russian Government find this that it compelled every household to contribute a supply of smoked fish during the season to be stored away as a public provision, and doled out in time of scarcity under stringent regulations. But abstinence of this sort (barely to tide over a crisis) could not account for the origin of accumulations. It was essentially a temporary expedient, and barely effective even for its temporary purpose.

It is doubtful, however, whether even in presence of a periodically recurring crisis like this the savage ever really practices any self-denying abstinence in the season of plenty, not only because abstinence is hateful to him, but because there is really no necessity for it, as he is certain, if not to-day, then to-morrow or the next day, to catch more fish than he wants, in which case he can eat his fill as usual and yet save. But, again, the saving does not consist in abstinence, but in exertion; that is, in industriously preserving and putting away what he does not want at present, instead of idly leaving it to rot.

He does not eat his surplus straight off, because he does not want to—because he cannot. There is nothing to exchange it away for, and therefore nothing to do with it but put it by. Abstinence does not come in anywhere in any shape. Next day he has his day's food ready secured, so need not go fishing again unless he likes; but the question with him is not whether he shall eat or go hungry, consume or abstain, but whether he shall work or be idle.

He decides to work, and makes (say) a net, which once made lasts a long time; and so by the intelligent use of his spare time he gradually accumulates a variety of goods—nets and lines, spears, and axes, pots and baskets, clothing and ornaments, generally intended to satisfy some immediate want or fulfil some immediate purpose, but any way all of a more or less durable nature, outlasting their first use, often outlasting many successive uses, and so accumulating faster than they are worn out.

But to commence an accumulation in this way it is not necessary even that he should on any one day catch more

fish than he wants: it is sufficient if he catches what he does want quickly, and so have all the rest of the day (not to speak of his idle evenings round the fire), wherein by simple diligence, without any abstinence, he can accumulate possessions to an indefinite extent.

If we take the case, not of an Indian who lives by fishing, but of an African who lives by cultivation, the needlessness (so to speak) of abstinence comes out still more clearly. For while the Indian's supply depends mainly on what he catches from day to day, the African's depends upon a series of operations conducted at a particular season. His supplies consist of his crop, and his crop all comes in together in a lump. Those, then, will have abundance, and will be able, without practising any abstinence, to live comfortably on that abundance, who have put in a sufficiency of ground, and those will be badly off and have to go on short commons who have put in an insufficiency.

Abstinence will count for very little either way. Those who have put in enough crop will be able to live luxuriously and even wastefully to some extent, and yet have plenty over, while those who have not put in enough will run short, and will hardly be able to put by for the future, even though they stint themselves exceedingly. It is all a matter of doing enough work at the right time.

But since his food consists of his crop, there will be two long periods, between seed time and harvest, and between harvest and preparation time, in which the African will have plenty of spare time on his hands wherein to produce all kinds of manufactured articles, nearly the whole of which will be of a more or less durable character, and which there is no temptation to consume except by ordinary wear, and which, therefore, will accumulate.

So far, following the example of the economists, we have confined our illustrations to savage life because the working of natural processes can be best seen when reduced to their simplest elements, and because it is amongst savages that the foundations of accumulation must have been laid, for without some accumulations they could not have emerged from the savage state.

If we turn to the other end of the social scale—to the millionaire capitalist—it is clear that no self-denying abstinence is required on his part to permit a gradually accumulating mass to grow up from his yearly income, and, as a matter of fact, he very rarely does practise any such abstinence; and

though it is true that abstinence consists not only in putting one's self on short commons in the matter of food but in denying one's self any enjoyment of consumption, no matter what, still the ways in which a rich man, growing richer, can find any gratification in really *consuming* goods is very limited.

He may, indeed, *spend his whole income* very easily, and find gratification in so doing; but spending money is one thing, consuming goods (in the sense of using them up and destroying them) is another. Most of the spending is mere transfer of possession or change of form. If a man loses his money in gambling, the money merely changes hands. If he spends it in pictures, furniture, and so on, he is merely changing his wealth from one shape into another. The quantity of goods that the most reckless spendthrift really consumes (in the destructive sense) is very small.

But it will be said the poorer classes in any highly organised community such as ours must practise actual abstinence, or at any moment, through sickness, accident, loss of employment or of vital power, they will assuredly find themselves in dire straits. No doubt; but this abstinence enjoined on the labourer is not designed to add to the existing mass of accumulations, but only to ensure his having something to consume when he is not in a position to earn anything; and he is not much given to abstaining for either reason.

Human nature is so constituted that, as a general rule, men will not deliberately make short commons shorter still in order to provide against a remote and problematical contingency; for life is uncertain, and the contingency therefore will always be problematical.

Those (and they are many) who hold that the only, or at any rate the chief, hope of bettering the labourer's condition is by encouraging him to restrict his already scanty indulgences in order to provide against sickness or old age, apparently fail to realise that this is not bettering his condition at all, but only changing the period of his deprivation, spreading it over his youth when his powers of enjoyment are keenest, instead of postponing it to a later period which he may never live to see.

What the labourer wants, and what the Philanthropist and the Reformer want for him, is not a greater pinch in the present as insurance against a worse pinch still in a doubtful future, but the improvement of his condition *now;* the power not to save more, but to consume more.

Consumption is the crown of production. What else do people produce goods for but to consume them? The proper aim of human labour is not the piling up of an imposing mass of accumulations, but the satisfaction of human wants, and the labourer's wants must be much better satisfied than they are at present before he is likely to do much in the way of piling up.

I may sum up my position so far in these words: Given industry and intelligence, under just laws, and wealth *must* accumulate, no matter how reckless and improvident a people may be. (Of course, if they are not reckless and improvident it may accumulate faster; but that is understood.)

Suppose such a race, intelligent and industrious, living under ordinarily favourable conditions, but so reckless as to have absolutely no care for the morrow, each (being industrious) earning as much as he can, but (being improvident) earning it only to spend it as fast as he gets it,—every one living up to his income from day to day; then wealth would accumulate rapidly. For, as I have said, spending money is one thing, consuming goods (in the sense of using them up) is another. The vast majority of goods produced, even of those required for immediate use, consist of articles which, being more or less durable, are produced faster than they are worn out, and so accumulate; and transferring goods from one person to another, or converting them from one shape to another, is not destroying them,—is not "consuming capital."

But, it may be said, so improvident a people as this, though they might undesignedly accumulate vast possessions, would always be in imminent danger of starvation. A bad harvest, or any one of a thousand likely accidents, might cut off their daily food supply, and, as no one had laid by for the morrow, they must all die.

Even if this were true, it would be quite beside the question; for the question is whether accumulations, such as they are, are due to self-denying abstinence, not whether these accumulations are always of the kind most necessary; and a man indisputably rich, and with all his riches around him, may die, and often has died, of starvation, as in a beleaguered city or shipwreck.

But it is not true that such a people would be in any more danger of starvation than we are. For the division of labour is one necessary consequence of energy and intelligence, and with such a people, as with us, the production of food would

fall into the hands of one class, the storing it to another, the distributing it to a third, and so on, each making its living by so doing; and each, therefore, in pursuit of its regular business would produce as much food as possible, store it as carefully and distribute it as opportunely merely as a matter of business, that is, merely in order to earn from day to day as much as it could in order to spend it from day to day.

The acquiring impulse, as distinguished from the saving impulse, would always ensure the existence of an excess supply available whenever wanted; and even if by some accident this supply appeared likely to fall short of its required amount, or to be in danger of destruction, the desire of immediate gain, apart from any prudential considerations, would set an increased number of people to work at once to produce more food before the crisis came.

As knowledge increases, as laws become more just, as the distribution of wealth becomes more equitable, and income comes to represent work, accumulations will become so abundant, and the morrow's return to labour so certain, that abstinence will become less and less incumbent on anyone, and labour will come to be looked on in its proper light as a means of satisfying human wants, not for the piling up of needless wealth, often in the hands of persons who, doing nothing to earn it, have yet so much that they do not know how to spend it.

But as to the general proposition I go further still, and while admitting that here and there abstinence of the self-denying sort has added to accumulations, yet, taking it on the whole and in the manner in which it is habitually practised, I submit that abstinence, so far from adding to accumulations, actually restricts them, because it checks production.

Suppose a number of people suddenly determine to save to the extent of a quarter of their income; and let bread, boots, and tobacco (representing food, clothing, and enjoyments) be the articles they have been habitually consuming, and in which they now propose to save. If they continue their customary purchases, putting by a quarter of them in a strong-room for future use, the result will be that the bread will certainly spoil, the boots and the tobacco deteriorate, and so many useful articles not only lie uselessly idle, but actually go to waste. But we need not dwell upon this, because we all know that the saving will not be effected in this way.

The abstainers will not hoard up their purchases, but discontinue them. No goods will be accumulated at all.

What the abstainers will save is money. If they saved it in the shape of coin, hoarding it, there would again be no accumulation. The money would be lying uselessly idle instead of circulating usefully, and that is all. A little wear and tear would be saved no doubt, but that is hardly worth mentioning. The money was coined for the sole purpose of being circulated, and the withdrawal of so much of it from circulation would disturb prices, cause a tightness in the money market, and derange trade generally. Society would be none the better for its withdrawal, but the worse. But we need not dwell on this supposition either, for we know that the saving will not be effected by hoarding coin any more than by hoarding goods. It will be effected by contracting expenditure, by waiving receipt of so much income or wages due, or accepting it from one person only to transfer it to another, and keeping the claim suspended to come down by and by on somebody. So that, so far as the abstainers themselves are concerned, they will have added nothing to the stock of accumulations, but only a lien on the accumulations of other people.

What, now, will be the effect on other people? Those who have been supplying the abstainers with bread, boots, and tobacco will suddenly find a quarter of their goods left on their hands. There will be stagnation in those trades, with all its inconvenience and distress. After a while, finding their customers are resolved to buy only the reduced quantity, the sellers will have to clear out their goods at whatever price they can get, even at a loss, and will have to reduce their production for the future in view of the diminished demand, thereby throwing so many people out of employment, who, under the existing conditions of society, will either crowd into other employment, bringing down wages, or will have to be maintained by charity.

Thus there will be a dead loss all round. The abstainers will have lost their accustomed comforts, the producers their market, and the labourers their employment. There will next year be no more old accumulations standing over, while there will be fewer newer accumulations brought into existence.

Saving, then, which consists not in preserving goods but in ceasing to buy them, is illusory. For goods are made only to be consumed, and if A ceases to consume them, B will cease to produce them, unless C takes them instead; that is,

unless one man's increased consumption counterbalances and so cancels another's abstinence. To realise the futility of "saving" in this way as a means of adding to accumulations, we have only to suppose the case of everybody determining to save, ceasing to spend, and allowing his income to accumulate as a deferred claim. Then everybody will have a claim over somebody else; the claims will cancel each other, and the supposed accumulations vanish.

Now consider the bearing of this on one of the most burning questions of the day, the war between Capital and Labour, exemplified by these continual strikes—strikes which, no matter how often the men are defeated (or apparently defeated), grow more numerous, more extensive, and inter-related, more highly organised, more bitter and more dangerous every year. The economist, who is assumed to be an expert and authority in these matters, and who is generally a hard-headed clear thinker, shows something like imbecility in dealing with this question. He hears that Labour has risen against Capital, and instead of enquiring what the *thing* is which the combatants call capital and are fighting about, he seizes upon the *word*, to which he attaches a meaning quite different from theirs. He declares to them that capital means food, tools, machinery; that these are necessary to labour, and the labourer is therefore a fool for fighting against them.

But the labourer is not fighting against these. He knows as well as the economist that these things are necessary to labour, and he is fighting for them, not against them, to get what he considers a fairer share of them, not to do without them. The "capital" which the labourer is fighting against is not what the closet philosopher understands by the word, but what both employer and employed, the financier in Parliament and the merchant in the city, the seller and the buyer, the creditor and the debtor, the whole world, indeed, except the economist, understands by "capital," and that is *money*. Not money in the restricted and technical sense of coin only, but money in its broad everyday commercial sense of *purchasing power*, no matter in what shape—coin, notes, title deeds, scrip, bank balances—that which gives its possessor command over the goods and services of other people, and constitutes him in the eyes of the world a monied man.

This tremendous power, known as capital or money, which rules the market, floats companies, starts enterprise, determines whether labour shall or shall not have the opportunity

to earn a living, and *fetches interest,* will be found on examination to consist, not of foods, tools, instruments of production, but of claims. Claims founded on past services, real or supposed; often real and just, but often purely illusory, often representing an injury done, not a benefit conferred (as in the "savings" afore-mentioned), often founded on trusts, rings, monopolies of one kind or another, on some one having got possession of something which was necessary to other people, land, purchasing power or what not, and charging other people for the mere permission to use it, and moreover originating for the most part in the acts of somebody untraceable, long since dead and forgotten, but whose tribute-levying power has been handed down from successor to successor, gathering like an avalanche as it descended.

This capital which rules the world does not consist of food and tools. If it did, the grower of food and the manufacturer of tools would be lords of the industrial world, and we know that they are not. We know that both the grower of food and the manufacturer of tools are too often at the mercy of the man who has neither the one nor the other, who has nothing at all, indeed, but a big bank balance representing savings and consisting of accumulated claims; who often has not furthered any single enterprise, has not done a hand-stroke towards it, has not designed or directed it, has not grown the food or manufactured the tools with which it was carried on; has not furnished a single requisite for it, but only invested in it. All the requisites for that (or any other) enterprise were present independently of him; the people willing to work, the land to work on, the food, the tools to work with, the brains to devise and direct; but precisely because the proceeds of all previous work had gone (barring mere maintenance and a trifle over) not to the men who did the work but to "capitalists," whose all-devouring claims absorbed all the profit, therefore the real workers have no "capital" of their own to undertake anything. The labourers cannot buy the food and tools, the food-growers and tool-makers cannot hire the labourers, for want of the money. So both, though they have all the requisites between them, have to wait till a big capitalist appears, approves, and invests. The very fact that he has already got much more than his proper share of the proceeds of previous work enables him to appropriate the lion's share of this work also, in which he takes no real part whatever. He uses his accumulated claims to establish further claims still. This at

any rate is the worker's view of the situation, and it is well to recognise it and not pretend that they are quarrelling with the requisites of production.

Food (in the mass, before it reaches the labourer) and tools are nothing to their possessor unless he can "*realise*" them (turn them into money); but money can command both food and tools. The capitalist has not the food which the labourer requires, but he holds the key of the granary, and no one can get a morsel, not even the man who grew the grain, unless *he* turns the key. He contributes nothing to enterprise; neither the labour that is the active factor in production, nor the food the men work on, nor the tools they work with, but he controls the whole course of industry, and holds a perpetual lien on the proceeds, and the more he "saves" out of his income the harder it becomes to find employment, and the heavier grows the burden of the toll which industry must pay.

Well, I am not going into the ethics of the question. But I wish (1st) to remind those who take upon themselves to lecture and scold the labourer for quarrelling with capital, and who insist that it is his friend and ally, that words are but the arbitrary signs of ideas and have no natural and inherent meaning. Their meaning is determined solely by custom, the custom of those who habitually use them. Further, that "capital" is essentially and emphatically a business term, in full popular use before economists were dreamt of, and by them borrowed from business men; and that if they want to be listened to they will enquire what the business man understands by the term, and frankly accept his meaning instead of quarrelling with him for not meaning something else. And (2nd) to show that the "saving" which the economist values so highly and inculcates so assiduously is mainly imaginary so far as real utilities are concerned; that it rather checks than promotes accumulations; that the "capital" arising out of it drains industry instead of assisting it; and lastly (though I have no space to go into this) that the tendency of its accumulating tribute is to outrun legitimate earnings and so produce periodical crises.

What, then, is the moral of our discourse? Are we to take no thought for the morrow? make no provision for the future? Certainly we ought; and the ways of doing so are chiefly three—

1. By avoiding waste. This is saving in the strictest sense and in its most legitimate form, but it is quite a different thing from the self-denying abstinence of the economist. The thrifty

housewife who saves all the bones for the soup, who never strikes three or four matches when one will do, who cuts out her material so as to make it go as far as possible, either adds to accumulations or saves labour, one or the other, and yet foregoes none of her enjoyments, but rather increases them.

2. By spending our money or our labour in producing things which will last rather than things which are quickly consumed in the use; but even this may easily be overdone. However, it represents judicious expenditure and not saving at all (in the strict sense), so it is rather outside the limits of our subject,

3. By doing to a limited extent what I may have appeared to denounce—that is, by "*saving money.*"

Remember that the question now is—How we are to provide for the morrow, not how we are to add to accumulations. The two things are quite different. The tendency of "saving" is always to check production and (under existing conditions) to throw labourers out of employment, but if kept within due limits, though it adds nothing to accumulations, but rather diminishes them, it does good by equalising fortune and averting disaster. Its effect is like that of insurance of property. There is more loss by fire and shipwreck since insurance was introduced than there was before. Not only because there are always scoundrels who will burn their houses or wreck their vessels feloniously for the sake of the insurance, but still more because people do not now make nearly the same efforts to save burning houses and sinking ships. When a man's all was in his house or his ship he worked as for dear life to save it, and his neighbours in sympathy and as a point of honour did their best to help him, even at the risk of their lives. They are not nearly so strenuous now. Formerly when there was a fire everyone rushed to put it out. Now they ask first whether it is insured, and, if it is, half of them go quietly back to their business, and the others, though they may work well, give up much sooner, and in no case make the same desperate efforts,—unless they are firemen, perhaps, with whom it is a point of honour.

For all that, insurance is an excellent thing. An arrangement by which utter ruin to individuals is averted by distributing the loss amongst people who are prepared as a matter of business to accept it, is well worth some cost; and the benefit of "saving" is of much the same nature. It represents no increase of accumulations, but the contrary,

but it averts suffering. Saving, when judiciously effected and kept within modest limits, represents a lien founded on previous self-restraint by the sick and the old and the unfortunate on the healthy, the young, and the successful. It is a good thing, but the relief secured comes out of current production, and represents no increase of wealth.

5.—DISTURBANCE OF THE POPULATION ESTIMATES BY DEFECTIVE RECORDS.

By H. H. HAYTER, C.M.G., *Government Statistician of Victoria.*

In the decennial period intervening between the censuses of 1881 and 1891 the population of Victoria actually increased by 278,059, but the apparent increase, or that arrived at by adding the excess of recorded births over recorded deaths to the excess of recorded arrivals over recorded departures by the seaboard during the same interval, was 345,046, or 66,987 more. In like manner in New South Wales, whilst the census showed an actual increase of 381,033, the apparent increase was 476,517, or as much as 95,484 more; in Queensland, whilst the actual increase was 180,193, the apparent increase was 212,206, or 32,013 more; and in South Australia (exclusive of the Northern Territory), whilst the actual increase was 38,798, the apparent increase was 65,071, or 26,273 more. Western Australia and the Northern Territory having little, if any, land communication with the other colonies, it is not necessary to take into account.

It is thus apparent that the census returns of 1891 showed a considerably smaller population in every one of the colonies treated of than that indicated by the numbers obtained at the previous decennial census added to the excess of births and arrivals over deaths and departures which had been recorded since that census was taken,—the total excess of the apparent over the actual population being 220,757.

It is evident that if an accurate census of all the colonies named was obtained in 1881 and again in 1891, which there is every reason to believe there was, and the births, deaths, arrivals, and departures occurring between the dates of those censuses had been recorded correctly, the apparent or calculated population of the part of Australia referred to would, in 1891, have equalled its actual or census population. This, of course, would only be the case for the colonies combined,

not for the individual colonies, as no attempt is made to take a complete account of persons passing from one colony to another overland.

The fact, however, remains that, whilst in each one of the colonies every death which occurs is supposed to be registered and every departure to be recorded, and elaborate machinery is provided by the respective Governments to give effect to those operations, as many as 220,757 persons in ten years, or an average of over 22,000 per annum, managed to disappear from the eastern half of the Australian Continent without their departure being noticed.

How is this leakage to be accounted for? The deaths which escape registration must necessarily be few, as in all the colonies it is illegal to bury a corpse until the death has been registered, and there is every reason to believe that this law is not evaded. The loss referred to must therefore take place by sea.

The captain of each vessel arriving in any Australian port is required to furnish a list of the number of passengers his vessel brings; and the captain of each vessel departing from any such port is required to furnish a list of the number of passengers his vessel takes away. These lists are, doubtless, very nearly correct so far as the arrivals are concerned, but not so as regards the departures,—the lists relating to which are systematically defective, as is admitted by the Customs and Immigration Authorities, and by the captains of the vessels themselves. The manner in which the defects occur is as follows:—

All passengers who take their passages beforehand, or are known to be in a vessel when she sails, are included in the list furnished to the Government; but it almost always happens that passengers come on board at the last moment, even up to the time of the vessel's sailing, and are not known to be on board until after the vessel is at sea. They are then discovered or make themselves known, pay their passage money, and are duly entered in the list presented at the port of the vessel's destination.

From enquiries I have made I am led to believe that these defects occur but rarely in vessels sailing to distant countries, but they occur very commonly in those engaged in the intercolonial trade. I am informed that quite a number of persons whose business or inclination frequently leads them to travel backwards and forwards between the colonies by sea habitually neglect to take their passages beforehand,

and are consequently, as a rule, omitted from the records of emigration: indeed, the oftener they repeat the process of journeying from colony to colony the less necessity they seem to find for notifying their intention of taking a passage. The effect of this will be understood by the following illustration:—

A Melbourne man, having business in New South Wales, gets on board a steamer about to start for Sydney; and, not having taken his passage beforehand, is not included in the passenger list furnished to the Melbourne authorities, and is consequently still considered to form a unit of the Victorian population. His name is taken down between Melbourne and Sydney, is duly entered in the list furnished at that port, and he is set down as an addition to the population of New South Wales. His business in Sydney having been completed after a stay which may be long or short, as the case may be, he goes on board a steamer for Melbourne, again without taking his passage: he is therefore not included in the passenger list, and is still considered to be in New South Wales; but, being entered in the inward list furnished on the vessel's arrival at Melbourne, he is added to the Victorian record, and contributes one to the next quarterly estimate of population made and published. Thus, every time he makes the round trip by sea he adds a fictitious unit to the estimate of the population of each of the two colonies between which he travels, or two such units to the estimate of the population of the whole of Australia.

It will be observed that the errors thus arising do not cancel one another, as errors sometimes do, but are always in the direction of causing the departures to appear fewer, and, consequently, the inhabitants of the colony to appear more numerous than they really are.

As more men than women travel by sea between the colonies, and as, moreover, provision for comfort when travelling is more often attended to in the case of the latter than the former, a larger proportion of the passages of women than of men are generally taken beforehand; and the lists of females are the more complete in consequence, with the result that the disturbance to the population estimates is invariably less in the case of the female than in that of the male sex; and thus it was found on the last census day that, whilst the apparent increase of the male population of the four colonies under notice was greater by 173,124 than its actual increase, the apparent increase of the female population

of those colonies exceeded the actual increase by only 47,633.

It may be remarked that the disturbance to the population estimates through a considerable number of the departures not being recorded, whilst a close record is kept of the arrivals, is not peculiar to the Australian Continent, but applies equally to the insular colonies of Australasia,—the apparent increase of population between 1881 and 1891 having been greater than the actual increase by 15,092 in the case of New Zealand, and by 10,338 in the case of Tasmania.

It should, moreover, be pointed out that the number of unrecorded departures is, as a matter of fact, always greater than the figures show, inasmuch as, whilst a practically complete registration of the deaths takes place as already stated, a considerable number of births in all the colonies escape the vigilance of the registering officers, and remain unrecorded. If this were not the case, the numbers showing the apparent increase of population would be obviously greater than those indicated. The births registered during the last intercensal period in the four continental colonies under notice numbered 891,388. Allowing 5 per cent. on this number for births not registered, or 44,569—which allowance is believed rather to understate than to exaggerate the truth—the total excess of the apparent over the actual population of those colonies would be increased from the number already quoted (220,757) to a probable one of 265,326, or an average of 26,500 per annum.

How is this disturbance to be avoided in the future? I have tried to remedy it so far as Victoria is concerned by correcting the outward passenger lists with the inward lists received from the other colonies of the group; and this answered fairly well whilst the steamers of the Peninsular and Oriental Company did not go further than Melbourne, and the Oriental, Messageries, and Austrian Lloyds' steamers were not running; but since so many lines of British and Foreign steamers visit Melbourne, calling at Western and South Australia before they arrive, and going on to New South Wales, and perhaps Queensland after they leave, the passengers from and to the various ports and places are so much mixed up in the lists that these afford no assistance whatever. If greater care were taken in recording the port at which the passengers embarked and that at which they signified their intention of disembarking, an interchange of lists might answer the purpose; but concert between the

colonies is necessary to attain this end; and this will, doubtless, exist after federation has become a fact. But is it necessary to wait for federation, which may not be accomplished for years to come? I have more than once urged upon my Government the desirability of the Immigration Authorities of the various colonies meeting in conference with a view of better means being arrived at of obtaining a true record of the intercolonial migration; and I do not look for much improvement until this takes place. Were such a conference to be held, the statistical departments of the various colonies might be of considerable assistance to it; and this I am quite sure would be willingly rendered.

The defects I have drawn attention to indicate the desirability of a census being taken oftener than once in ten years, and add another argument, if such were needed, to the many cogent reasons which have often been adduced in favour of such a course. Much to the credit of Queensland and New Zealand, a quinquennial census is now taken regularly in both those colonies. In neither of them, it may well be assumed, is the Treasurer anxious to spend the public money unnecessarily; and it may be set down as a certainty that if the proceeding were not found to be advantageous it would be discontinued. It is much to be desired that the example set by these two colonies may, after this, be followed by every other colony of the group.

I believe that the majority of the statesmen of Australasia, especially those of them who are the most thoughtful and far-seeing, are in favour of the population being enumerated more frequently than it is at present; and I submit that the cost, which after all is not ruinous, ought not to stand in the way of a census being taken at least quinquennially. I have no hesitation in saying that the extra money expended would not be wasted, but would be found, in the end, to operate beneficially in the case of each one of the communities concerned.

6.—THE CONCENTRATION OF POPULATION IN AUSTRALIAN CAPITAL CITIES.

By H. H. HAYTER, C.M.G., *Government Statistician of Victoria.*

THE tendency of population to gravitate to large towns, and especially to metropolitan towns, is most strikingly evidenced of late years. Thus Greater London, according to the recent

Census taken in 1891, contained the astonishing number of 5,657,000 inhabitants, as against 4,767,000 in 1881, and only 3,886,000 in 1871; Paris had 2,427,000 inhabitants in 1891, as against 2,240,000 in 1881, and only 1,989,000 in 1876,—these large increases having taken place whilst the whole population of France remained almost stationary; Berlin had 1,609,000 in 1890, as against 1,315,000 in 1885, and only 826,000 in 1871; and Vienna had 1,350,000 in 1887, as against only 967,000 in 1875.

The growth of the population of the Australian capital cities has been even more marked than that of the cities of the old world. Thus, in the ten years ended with 1891 the population of Greater Melbourne increased from 283,000 to 491,000, or by 74 per cent.; that of Sydney from 224,000 to 387,000, or by 72 per cent.; and that of Adelaide from 104,000 to 133,000, or by 28 per cent.; whilst in the five years ended with 1891 the population of Brisbane increased from 74,000 to 92,000, or by 25 per cent.

The reasons which have led to this important development of modern times are not far to seek. In old countries before railways were constructed, and when no better means of internal communication existed than that afforded by ordinary roads, in some cases badly kept, and in winter almost impassable, a number of small towns was a necessity. They were not only the depôts for the supplies required for the use of the country residents, and the centres for the disposal of all descriptions of produce raised in the interior, but were the places where such residents found all they ever knew of life in the way of pleasure, recreation, and social enjoyment. Many during their whole lifetime never saw any other large gathering of population than that grouped in the nearest market town, some of whose inhabitants had never been out of sight of its buildings, or at any rate of the smoke of its chimneys. That they might some day visit the metropolis appeared impossible; for could it be imagined they would ever undertake a journey attended with so much difficulty, danger, and expense, and involving such a serious waste of time? Moreover, manufactories, and, as a natural result, manufacturing towns, sprang up near coal-pits; for it was less expensive to convey the manufactured article to the metropolis or the seaport than to carry thereto the fuel used in its fabrication.

All this was changed by the introduction of railways. By them communication to and from the interior both for goods

and passengers was made so cheap, so easy, and so rapid, that important small towns were no longer a necessity. They still continue to exist, as do many other institutions which are out of date; but their growth, if grow they do, is generally extremely slow, and many are even declining in population.

In new countries inland towns spring up and flourish until railways are constructed; but afterwards the tendency is all towards the metropolis. It is not probable that such cities as Ballarat and Bendigo, in Victoria, would have reached their present importance if railways had been made earlier. It could not under any circumstances be expected that they would now maintain as large a population as they did when gold-mining was at the height of its prosperity; but there has been little change in the prospects of this industry during the past ten years; and, if the towns referred to continued to supply a want, there is no reason why they should not increase in population at the same rate as the rest of the Colony. Instead of this, whilst the population of Victoria increased between 1881 and 1891 in the proportion of 32 per cent., the population of Ballarat increased only 10 per cent., and that of Bendigo less than 2 per cent. In the same ten years the population of Melbourne increased by as much as 74 per cent.

Melbourne now contains 43 per cent. of the population of Victoria; Adelaide, 42 per cent. of that of South Australia; Sydney, 34 per cent. of that of New South Wales; and Brisbane, 23 per cent. of that of Queensland. The contrast between the proportion that the population of these and that of the old world cities bears to the total population of the countries in which they are respectively situated is very marked, especially when it is remembered that the old world cities, as has been already stated, have largely increased in population of late years. Thus London, the most wonderful city in point of size the world has ever known, only contains 19 per cent. of the population of England, and less than 15 per cent. of that of the United Kingdom; Paris contains less than 6 per cent. of the population of France; Berlin contains only 5½ per cent. of the population of Prussia, and only 3 per cent. of that of the whole of Germany; Vienna contains less than 5 per cent. of the population of Austria, and less than 3 per cent. of that of the whole of Austria-Hungary.

Each census, as compared with the previous one, shows an

increase in the proportions which the populations of the several Australian capital cities bear to the populations of the respective colonies; and this is especially observable in the case of Melbourne, the population of which, to the total population of Victoria, was in the proportion of 26 per cent. in 1861, 29 per cent. in 1871, 33 per cent. in 1881, and 43 per cent. in 1891. I am not able to go so far back in the case of the other capital cities; but in Sydney the population rose from 30 per cent. of that of the whole of New South Wales in 1881 to 34 per cent. in 1891. In the same decade the population of Adelaide rose from 37 per cent. to 42 per cent. of that of the whole of South Australia; and in the 5 years ended with 1891 the population of Brisbane rose from 22 per cent. to 23 per cent. of that of the whole of Queensland.

The increases which have occurred point to the probability that when the census of 2001 is taken, half the population of Victoria, and perhaps also half that of South Australia, and 40 per cent. of that of New South Wales, will be found to be living within the metropolitan limits. That so large a proportion of the population of a country should be congregated in its capital city is, so far as I know, a circumstance quite unprecedented; and, for that reason, no previous experience can afford an indication of what the effect may probably be.

We may, however, speculate as to whether it will be for good or for evil. I am inclined to think there is a considerable preponderance in favour of the former.

It is surely an advantage that there should be in a country one grand centre—the seat of its Government as also of its commerce and manufacturing industry—the point from which all roads, railways, and other means of communication with the interior diverge, conveying thereto the articles which are necessary to satisfy the requirements of the mining, agricultural, pastoral, and other country populations, as well as the point towards which such means of communication converge, bringing back to town the productions of the interior for manufacture, use, and export.

The evil arising from there being several small or medium-sized centres of population instead of one large centre is shown in the case of New Zealand, which, in consequence of its divided and insular formation, has necessarily a number of towns situated at various parts of its sea-coast, with railways branching off from each town. That New Zealand

suffers from this state of things is well known,—one effect of it being that of all loans to be raised, or public moneys to be spent, each centre claims to have a share, not because it is actually wanted, but in order to give work in the district, with the result that not unfrequently useless railways are made and unnecessary public works constructed. This scramble for the public funds has, besides, as may well be imagined, a demoralising effect on both electors and legislators.

The inconvenience of having more than one centre has to a slight extent been felt in Victoria. In the early days of railway construction Geelong was a sort of rival to Melbourne, and claimed to be the pivot upon which the social, political, and commercial interests of the Colony turned,—the result being that when it was proposed to make a railway from Melbourne to Mount Alexander and Bendigo, it was considered only right that Geelong—to which place there was already railway communication with Melbourne—should be the terminus of the line to Ballarat. Geelong afterwards sank into comparative insignificance; but, notwithstanding this, for a period of 30 years, persons having to go from Melbourne to Ballarat were obliged to travel a distance of 100 miles *viâ* Geelong, whereas the direct distance from Melbourne was only 74 miles. After all this unnecessary travelling and waste of time and money, it was at last found indispensably necessary to construct a direct line of railway from Melbourne to Ballarat; and, in consequence, the line from Geelong to that place is now comparatively little used, and will be probably even less so in future.

It must be admitted that whilst there are many benefits arising from extensive centralisation, there are also some strong objections to it. The country is more healthy than the town; and small towns, as a rule, are more healthy than large ones. If there is not so much wealth in the former as in the latter, there is also generally less poverty: there is, moreover, less luxury and extravagance, less vice and immorality, whilst fewer people live in slums. It would no doubt be desirable, especially in newly settled States, that more persons should live in the country, where they are generally producers of wealth, than in either small or large towns, where a much larger proportion of them are merely distributors or dependents; but, since this cannot be the case, the balance of advantage is, I think, as I have already said, in favour of cities being large and few instead of small and numerous.

It must be remembered that large towns of recent growth are spread out so as to cover a much larger surface in proportion to population than has ever been occupied by the older cities. The cheap and easy means of communication afforded by trams and suburban trains enables workmen and others, whose daily occupation requires their presence in town, to live in the suburbs; and, in consequence, slums, with their depraved and unwholesome concomitants, become proportionately reduced in number and extent. Greater Melbourne, with a population of half a million, is officially considered to extend over an area having a radius of ten miles from the centre of the city. The suburban portions are, of course, scattered,—gardens, grounds, and paddocks, some of large size, being attached to most of the residences—and there is room for much more building, without crowding. Still, extensive suburban villages are springing up outside the metropolitan limits; and I look forward to the day when the official radius will have to be lengthened.

There are, moreover, large reserves for recreation and amusement, which add considerably to the extent of breathing space, in most of the Australian cities, of which they have been aptly termed the lungs. Portions of these reserves are set apart for the practice of cricket, football, bowling, bicycling, and other out-door sports and athletic exercises, for the enjoyment of which the very general adoption of the eight hours' system of labour affords ample leisure. The Australian youth are proverbially fond of such exercises; and the frequent indulgence in them by town residents goes a long way towards rendering them no less robust and vigorous than their country fellow colonists. Efficient systems of sewerage, an abundant supply of pure water, and sanitary measures and regulations have already done much towards improving the healthfulness and diminishing the mortality of even the most crowded parts of towns, both old and new; and if these are persisted in, and continued efforts are made to stamp out contagious and infectious diseases as they occur, it may be hoped that, in the future, the death-rates of even our largest towns may compare not unfavourably with those of our rural districts.

7.—THE EVOLUTION OF HOSTILITY BETWEEN CAPITAL AND LABOUR.

By MRS. A. MORTON.

To account, even partially, for the present condition of the labouring classes in England and Australia, and their present attitude towards capital, it seems to me that we must look back into the past relations between employers and employed.

At the outset, let me say that I am dealing with the subject from the concrete and human rather than from the abstract and purely theoretical standpoint.

The subject of the relation of capital to labour is attractive alike to the earnest student and the dilletante idler. With the hair-splitting distinctions of the one, and the confusion of thought and expression of the other, this paper has nothing to do. For its purposes it will be sufficient to define capital as the wage-payer, labour as the wage-earner.

And, since no one with any interest in humanity can possibly be indifferent to anything which affects the mass of toilers who live in our own land, and speak, with some moditions, our own tongue, it is surely unnecessary to apologise for the subject, or do more than crave kindly indulgence for the manner of treating it.

The past attitude of Capital towards Labour.

There was a time in the history of Europe when the greater part of the population were everywhere bereaved of their personal liberty, and lived entirely at the will of their masters. As vassals, or serfs, or slaves, they lived and died without ever realising what freedom, as we understand it, meant. In England the first direct legislation in connection with labour was enacted in the reign of Edward III. An Act, called "The Statute of Labourers," was passed, which bound all labourers who were in a position to take employment to accept it at a rate of wage that was much lower than they were then receiving. A refusal to accept service at the lower remuneration was punished by imprisonment; and a master who paid more than the stipulated wage was liable to a fine of double the amount.

Two years later, on the plea that the General Statute was evaded in various ways, another was passed, which entered more into detail, and made it illegal for masons and carpenters to enter into any agreement with each other, when

separately engaged, as to the particular branch of work they would undertake, and bound them to execute any work assigned to them by their master; though this did not prevent their undertaking contracts jointly, and dividing the work at their own discretion, "providing it to be done well and lawfully." A workman was not allowed to leave his work in one town to go to another, under pain of imprisonment; and he might even be branded with a hot iron for absconding from work he had undertaken.

Down to the fifteenth century it was lawful to press men for service under the King. Stonemasons, bricklayers, carpenters, and other artificers were liable to be seized at any time or place and employed on public works at a rate of wages often below that ruling for private employment, with no choice but imprisonment as an alternative.

An Act was passed in the reign of Richard II., which decreed that no labourer might go from one place to another unless he bore a letter patent under the King's Seal specifying the cause of his going and the time of his return. In the same reign it was enacted that the Justices were to settle and proclaim between Easter and Michaelmas what should be the wages of day labourers.

In the reign of Henry IV. labourers and artificers were ordered to be put in the stocks for any evasion of the many laws that had accumulated for the regulation of labour; and any town which did not possess these moral persuaders was to pay a penalty.

Time after time the rates of wages and hours of work in the different trades were fixed with exasperating minuteness, only to break down with the strain of detail, or become abortive from the perversity of the human nature such legislation sought to control.

In the reign of Henry VIII. a vigorous attempt was made to deal with the unemployed question, by a decree which provided for the summary punishment by whipping of any person who, being able-bodied, refused work or was found begging. A persistent refusal to work when called upon to do so entailed the penalty of execution as a common felon.

For three years a law was in force under which vagrants might be taken up, branded with a hot iron, and made slaves for life; but this disgrace to the Statute Book was then repealed.

In the reign of Elizabeth an elaborate attempt was made

in another "Statute of Labourers," to deal with the relations between masters and men.

Among its enactments were that no person engaged in trade or husbandry might leave the county or shire where he was engaged to serve in any other without a testimonial, which was to be shown to the authorities at the place where he desired to make a fresh engagement, failing which he was imprisoned; and, if a satisfactory testimonial was not produced within twenty-one days, he was further punished by flogging. During harvest time the Sheriffs were empowered to seize able-bodied men, and even women, and compel them to serve in the fields; and refusal was to be punished by the stocks or by imprisonment.

All artificers and labourers hired by the day or week were required to work 12 or 13 hours a day during one-half of the year, and from daylight to dark the other half.

Legislation thus left the working classes no freedom of residence, choice of work, arrangement of remuneration, or limitation of hours of labour. They were not called slaves, for it was proudly boasted that England had no slaves; but they were looked upon as a distinct and inferior class to the governing powers—"a people to be ruled, and not to rule others."

From the middle of the eighteenth century the actual laws relating to labour have been steadily growing more liberal, especially as regards combinations of workmen, which had been many times suppressed with a high hand. Between the times of Edward I. and George IV. between thirty and forty Statutes were passed against the organization of labour. Even a combination of two or more workmen to raise the rate of wages, or shorten the hours of work, was a criminal action as late as the year 1824. A Select Committee in that year reported on the laws that had been enacted against Trades Unions, and declared that, in their opinion, they were ineffective and irritating. In accordance with their recommendation an Act was passed, repealing the law against Trades Unions; but the sudden freedom revealed the existence of so many societies and combinations of workmen, which had been secretly organised, and now first dared to show themselves openly, that another Select Committee concentrated its combined intellect on the situation, and recommended that the old state of things be restored, and that the Bill to legalise Trades Unions be forthwith repealed, on the plea that the combinations legalised by it were injurious to

trade and commerce, dangerous to the tranquillity of the country, and especially prejudicial to the interests of all concerned in them.

It was not until 1869 that the governing powers were sufficiently liberal in their policy to remove the restrictions which hedged round every attempt of the working men to combine for mutual protection. The Trades Unions Acts of 1871 and 1876 finally cleared away all obstructions to the freedom of labour in regard to its own terms and times.

The rapid growth of humanitarian sentiment during the last twenty years has probably, as much as anything else, tended to make the lot of the working men more endurable: for employers are, more than ever before, anxious to make all reasonable concessions. Numerous experiments in profit-sharing and in co-operation attest their desire to do all in their power to improve the existing state of things, and remove all cause for the use of the phrase "The Tyranny of Capital."

The present attitude of Labour towards Capital.

On the part of the working men, in addition to the secret societies which flourished everywhere, the universal discontent led to a great and organised attempt in 1864, to form a society that should settle the grievances that caused so much hostility between employers and employees.

An International Working Men's Association was formed for discussing and furthering the rights of labour. Its founders set forth that, notwithstanding the vast development of industry and the accumulation of national wealth, the lot of the working class was as hard as ever. All the recent revolutions and political reforms had been achieved only in the interest of the middle classes, leaving the position of the toilers unimproved. The emancipation of the working men must be the task of the working men themselves.

With this view the International Association was founded, which, while recognising truth, justice, and morality as the basis of its action, without distinction of creed, nationality, or colour, would serve as a common centre for the efforts of working men towards their complete deliverance from the tyranny of capital.

It rapidly spread eastward as far as Poland and Hungary, westward to America; and it had affiliated societies, with journals devoted to its cause, in every country of Western Europe.

At first its tone was moderate and its demands reasonable; but it became fired with the revolutionary spirit that animated almost all Europe at that time, until its very name became synonymous with socialism and tyranny of the worst kind.

In ten years it had burnt itself to ashes with the fire of its own internal dissensions, and was unable ever to rise again from its own ruin.

Yet, agitation of a more or less violent kind has continued ever since. Mr. Walter Besant, in his book "All Sorts and Conditions of Men," satirises the attitude of labour, in an account of a meeting at the East End, at which a violent speaker, who demands the abolition of everything, is cheered to the echo as representative of the feeling of the meeting, and indicative of the one remedy that would be acceptable to the world of labour at large. For years the democratic organs in England have urged that the people should not be content with a few representatives in Parliament, but should, by united effort, place in the House of Commons a power that would be great enough to control the destinies of the country, and that would force legislation of so drastic a character to be directed against their arch-enemy, Capital, that its head should for ever be put under the heel of Labour. The spirit animating labour found its strongest expression in the celebrated Communist Manifesto, which concludes by saying "The working classes have nothing to lose but their chains. They have the world to win."

The conclusion of some socialistic addresses by K. Marx, the German socialist, is of a sort calculated to deepen the feeling of unthinking readers against the present condition of things. He says:—"Capital is the most terrible scourge of humanity: it fattens on the misery of the poor, the degradation of the worker, and the brutalising toil of his wife and children. Just as capital grows, so grow also pauperism,—that millstone round the neck of civilization,—the revolting cruelties of our factory system, the squalor of great cities, and the presence of deep poverty, seated hard by the gates of enormous wealth."

Professor Huxley, in some able articles in "The Nineteenth Century," has demonstrated that, so far from being actually antagonistic, capital and labour are mutually dependent on each other,—are, in fact, so circumstanced that neither can live without the other; but the working classes do not read "The Nineteenth Century," and, if we may

judge from their utterances, are quite willing to abolish capital by absorbing it.

We have not forgotten the dockers' strike in London, nor the wave of pity and help that swept over all classes in Australia at the realisation that the dockers were men who had a grievance, and one that called for swift remedy.

The recent strike of London omnibus-men for the right to a little more leisure than was absolutely necessary for food and sleep has reminded us that much has yet to be done before the friends of labour in the older countries may abate their diligence; but, at least, the tide has turned; and although for centuries the attitude of capital towards labour was harsh, and even ferocious, the slow growth of time has so changed that attitude that little remains of it but the memory. True, the memory is still strong enough to embitter the relations betweeu the two; but, if in early days the masters sowed seeds of violence and oppression that brought forth a plentiful crop of hatred and retaliation, they are now doing their best to root up the ill weeds, and to rear plants of forbearance and helpfulness that shall yet grow to a harvest of peace and goodwill.

The condition of the working classes in Australia is immeasurably better than that of their fellows in the old lands. In this new and free country, subject, of course, to fluctuations such as affect all trades and all conditions at times, men have been able to obtain a fair wage for a fair day's work. In Australia, therefore, all that mass of past legislation, whereby capital sought to coerce labour may well be forgotten; and the workers may well consider capital from a newer and more liberal standpoint than is possible to the toilers who live where the effects of the past mistakes remain as a poisonous leaven to infuse bitterness into the bread of labour.

It is not easy, unless we adopt a theory imputed to Prince Bismarck, to account for the attitude of labour towards capital in this new land.

"Workmen," he says, "are insatiable in their demands. It is no use attempting to solve the labour question by listening to them, and striving to satisfy them, because God has not implanted in them the faculty of contentment."

It needs no proof but mere mention of the late maritime strike in Australia, or the present shearers' strike in Queensland, which is witness enough of the spirit animating labour, to show that its attitude towards capital is of the same

hostile kind as prevails in countries where the heritage of wrong in the past has justified the reproaches of the present. Even the phrases used in the old country to arouse in labour a fierce vindictiveness are imported here to justify or excuse a feeling of hostility that is almost ludicrously disproportioned to the cause.

In New South Wales the labour party has held for some months the balance of power in the House of Assembly, with perfect indifference to large questions of State policy, and with but one idea—to obtain legislation in their own favour. Already they have turned a Ministry out of office, and are helping to reverse the deliberate fiscal policy of the Colony—blind, deaf, dumb to all considerations but the advancement of trades unionism and the despotism of labour; and even their own disintegration and downfall in the general wreck do not seem to have taught them anything.

Whatever of hopefulness there is in the outlook for the future will lie in the fuller education of the people to a perception of their real wants, and a realisation that neither from their own side nor from their opponents, will they obtain redress for evils that are entirely of their own causing, and that can only be removed by a change in their own dispositions. Not in individual revolution, but in re-adjustment, must be the way towards a happier state of things; and, as Mr. Gladstone lately said, "Capital, and not labour, has hitherto had the upper hand: it is time that the balance should not be reversed, but redressed."

> "Ah, tho' the times, when some new thought can bud,
> Are but as poets' seasons when they flower,
> Yet seas, that daily gain upon the shore,
> Have ebb and flow conditioning their march,
> And slow and sure comes up the golden year.
> When wealth no more shall rest in moulded heaps,
> But smit with freer light shall slowly melt
> In many streams to fatten lower lands,
> And light shall spread, and man be liker man
> Thro' all the seasons of the golden year."

8.—ON THE LUNERAL: BEING A METHOD FOR DISCOVERING WEEKDAY DATES FROM THE YEAR OF OUR LORD TILL A FRESH ALTERATION IS MADE IN THE CALENDAR.

By W. E. STOPFORD.

Use.

HISTORY is condensed diary, and the dates of the one are the dates of the other in condensed form. Without dates all narrative is without an essential point. More than this, they often require to be full and complete. If I were to ask when such and such an event took place, and were informed on the 14th December, 1329, I should know it happened before or after another event whose date I was previously acquainted with. This would be comparative knowledge, with which I might be satisfied; but if I wished to make myself thoroughly at home with all the circumstances of the event, I should prefer to be told it occurred or commenced at 2·30 P.M., Thursday, 14th December, 1329. It is quite possible the specific knowledge I should then have acquired might account for other events immediately preceding or following it. In such a form as this should I find the date given in diary, which as reading is infinitely pleasanter, and far more reliable, than history. By tallying one with another, weekday dates confirm and establish the accuracy of other dates: on one occasion I came across a date in history that gave the day of the week, the day of the month, and two consecutive years, showing uncertainty in this respect, and by glancing at the Luneral I was able to decide upon one of them.

There seems, then, to be a call for some method of arriving at weekday dates, at least, of historical events, if one may be found to work with ease and fair simplicity, and such a one am I prepared to lay before you, together with the proof of its accuracy.

Method.

The Instructions state that all the letters in the square stand for Sundays; this is true in relation to the months, but in relation to the numbers which stand round, and which I propose to commence with, the letters stand for days of the week, B C D G P T V standing for Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday. In effect, the Luneral has two objects; first, to give the day of

the week on which 1st January falls in any year, and secondly, the date of the first Sunday in any *month* of that year, the one object declaring the other. I will now set before you the proof of the first object, and to save time will call the day of the week on which 1st January falls *the* day for any year, instead of New Year's Day, to be changed on 1st March in cases of Leap Year for the next following day of the week, that is to say, for the day of the week on which 1st January would have fallen if 1st February had fallen, as it does in ordinary years, on the same day of the week as 1st March. The day, then, for this year (1892) being Friday, that for last year was Thursday, and for the year before Wednesday. This principle, allowing two days for Leap Years, obtained from the birth of our Calendar till the year 1752, when an omission was made of some of the days of a month. It becomes then necessary to discover a weekday date previous to the alteration, and one, if possible, that we may feel as sure of as we do of to-day's date, in order to find the day, that is, New Year's Day for *that* year.

It must be borne in mind a weekday is not the date of an event, it is rather the date of a day of the month, and is shown to be right or wrong by tallying with another weekday in respect to another day of the month. So if the weekdays tally with one another in a diary, they must be either all right or all wrong; for if any Sunday fall on 3rd, the next Sunday *must* fall on 10th, and if these two dates chance to be given, they must either be both right or both wrong. It follows that if *all* the weekdays in a diary extending over a period of several years tally with one another in respect to the days of the month, all must be right, or all wrong. It is absurd to suppose all the dates in a diary are wrong; we may therefore conclude, from the mere fact of their tallying with one another, they are all right. I may here say the Luneral agrees with every weekday date in Pepys's diary, and I have chosen one of them, viz., Sunday, 2nd September, 1666—the date of the fire of London—to start from.

I must ask you now to refer to the proof of the Luneral, viz., Tables A, B, and C, which have been handed round, and without which I am unable to make my case clear. In Table A are given the months of the year, with the first seven days of the month below January, and the first day *only* below each of the other months, in their one possible relative position to 1st January in connection with the days of the week—1st February and March always fall three days

of the week later than 1st January, 1st April six days, and so on. Opposite the first seven days of January are placed the seven days of the week in every possible combination. Now, when 2nd September falls on a Sunday, as we saw in the case of the year 1666, 1st September falls on Saturday, and Table A shows that when 1st September falls on Saturday, 1st January falls on Monday, provided the year be not a Leap Year, which 1666 is not.

Having arrived at the day for a year before the alteration in the calendar, Table B gives the days for all the years from 1600 to 1800, which shows the day for 1700 to be Monday, and for 1600 Tuesday. It follows that as we go back in the calendar, a day of the week is gained in every centurial year, and by taking a century at a time Table C shows the day for the year 600 to be Friday. I will now put 6 opposite Friday with C over it to denote 600.* For the same reason 5 will go opposite Saturday, 4 opposite Sunday, 3 Monday, 2 Tuesday, 1 Wednesday, and 0 opposite Thursday. As a day of the week is gained in 100 years, seven days are gained in 700, and the day of the week therefore repeats itself every 700 years. This column, then, serves to show the days for the centurial years till 1700, if we divide them by 7 and take the remainder; and as each was Leap Year, we give each a second day, and commence with the year 400, as most conveniently placed, to arrange the units.

If the days for 400 were Sunday and Monday, the day for 401 would be Tuesday, so we place Tuesday under 1, Wednesday under 2, Thursday 3, Friday and Saturday under 4, 5 over Sunday, 6 over Monday, 7 Tuesday, 8 Wednesday, and Thursday, 9 over Friday, and 10 *below* Saturday. But as every centurial year is Leap Year, with only one day's difference between each, we may employ the same units for each as far as ten years, and if we complete our square, the difference of one day between each year, and one between each century, still remains. The day for 410 we found to be Saturday, but as this is not Leap Year, we require a fresh group of units. Having found Saturday in the left-hand column, we place 0 over it to stand for 410, then 1 and 2 over Sunday, Monday, and Tuesday for 411, 412; 3, 4, 5 over Wednesday, Thursday, Friday, 6 over Saturday, 7, 8, 9 over Monday, Tuesday, Wed-

* By substituting the seven days of the week for the seven letters in the square, this may be seen in the Luneral, where T representing Friday, in the left-hand column of letters is found opposite 6 under c b.

nesday, showing the day for 419 to be Wednesday, and for 420 it will be Thursday. We may now place 20 under Thursday in the top row, and by finding Thursday in the left-hand column, and using the lower group of units, we find 429 to be Tuesday, and 430 is Wednesday; 30 goes under Wednesday. In the same way we find 440 to be Monday, 450 Sunday, 460 Friday, 470 Thursday, 480 Tuesday, and 490 Monday. Some of the tens being Leap Year, and some not, two groups of units are necessary; but as all the centurial years are Leap year, one group of tens is sufficient. The only difference the alteration in the calendar made to the days of the week was that instead of repeating themselves every 700 years they do so every 400; and now that we have the tens and the units arranged, we can easily read the Luneral, starting from 1753 to test its accuracy, until we arrive at the current year, and on till we arrive at 2153 and discover the circulation every 400 years. With the tens and units in their places, the proof of the Luneral is in the reading, for it takes a second of time to read a year, and half an hour to go from the year 0 to the present time; as the Luneral goes on for ever, we may continue reading as long as we choose! Or we may reason as follows:—As we went back in the calendar we found a day of the week was gained in every centurial year; it follows that, as we advance in the calendar, a day of the week is lost: so if the day for 1800 be Wednesday, for 1900 it would be Tuesday; but as 1800 is not Leap Year, owing to the alteration, two days are lost; therefore Monday is the day for 1900, and Saturday for 2000. 2000 being Leap Year, only one day is lost, therefore Friday is the day for 2100, Wednesday for 2200, and so on.*

We now come to the months, and will represent the seven days of the week by seven letters of the alphabet. B now represents the day for any year in which 1st January falls on a Sunday; it will also serve to represent the first Sunday in January of the same year, so we place January opposite B in the last side of the square, and read in the year B the first Sunday in January falls on 1st. In Table A and under column 6, 1st January falls on Saturday, and the first Sunday in January falls on the 2nd. As V represents Saturday, this letter, two places removed from January, reads correctly as follows:—In the year V, or any year in which 1st January

* See Table C, after the alteration.

falls on Saturday represented by V, the first Sunday in January falls on the 2nd. And so on, till we reach column 1, when 1st January falls on Monday, represented by C, and the first Sunday in January falls on the 7th, when C is found seven places removed.

As January and October are similar months, we may add October to this row and pass on to February. 1st February in Table A falls on a Sunday, under column 4, and when 1st January falls on Thursday; therefore we place February, March, November, similar months, opposite P, the letter for Thursday. 1st April falls on a Sunday under column 1, when 1st January falls on a Monday, and we place April and July opposite C. In this way we may complete the months.

In conclusion, I wish to point out the fact you may not yet have noticed, that everything in the Luneral is in order; the letters are in alphabetical order, whichever way they are read, the units and centuries in numerical order; so are the tens, if we repeat the letters, and give two to Leap Years and one to ordinary years. The months are found in their proper order if we repeat the letters seven times, and give four letters to each month of 31 days, and five to each of 30 days, omitting February. This just occupies every letter in the square but one, and the circle of time is therefore squared!

I have been able in the time to set before you the method of the Luneral and a means of arriving with ease at its accuracy, and I have shown how anyone who wishes may draw it up for himself. This is all; but if anyone will employ the means, and in case of finding an inaccuracy, will kindly inform me of it, I shall feel obliged for the information. In the event of its being found accurate, I think for its simplicity the Luneral should be given greater reliance than history, which is frequently inaccurate, especially in the matter of weekday dates.

PROOF.

Table A.

1	2	3	4	5	6	7	Jan.	Feb.	Mar.	April.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
M.	Tu.	W.	Th.	F.	Sat.	𝕾.	1	.	.	.	.	.	.	.	.	1		
Tu.	W.	Th.	F.	Sat.	𝕾.	M.	2	.	.	.	1							
W.	Th.	F.	Sat.	𝕾.	M.	Tu.	3	.	.	.	.	.	.	1				
Th.	F.	Sat.	𝕾.	M.	Tu.	W.	4	1	1	.	.	.	.	.	.	.	1	
F.	Sat.	𝕾.	M.	Tu.	W.	Th.	5	.	.	.	.	1						
Sat.	𝕾.	M.	Tu.	W.	Th.	F.	6	.	.	.	.	.	.	.	1	.	.	1
𝕾.	M.	Tu.	W.	Th.	F.	Sat.	7	.	.	1	.	.	1					

Table B.

1600	Tu. W.	1610	M.	1620	Sat. 𝕾.
1	Th.	11	Tu.	21	M.
2	F.	12	W. Th.	22	Tu.
3	Sat.	13	F.	23	W.
4	𝕾. M.	14	Sat.	24	Th. F.
5	Tu.	15	𝕾.	25	Sat.
6	W.	16	M. Tu.	26	𝕾.
7	Th.	17	W.	27	M.
8	F. Sat.	18	Th.	28	Tu. W.
9	𝕾.	19	F.	29	Th.
1630	F.	1640	W. Th.	1650	Tu.
31	Sat.	41	F.	51	W.
32	𝕾. M.	42	Sat.	52	Th. F.
33	Tu.	43	𝕾.	53	Sat.
34	W.	44	M. Tu.	54	𝕾.
35	Th.	45	W.	55	M.
36	F. Sat.	46	Th.	56	Tu. W.
37	𝕾.	47	F.	57	Th.
38	M.	48	Sat. 𝕾.	58	F.
39	Tu.	49	M.	59	Sat.
1660	𝕾. M.	1670	Sat.	1680	Th. F.
61	Tu.	71	𝕾.	81	Sat.
62	W.	72	M. Tu.	82	𝕾.
63	Th.	73	W.	83	M.
64	F. Sat.	74	Th.	84	Tu. W.
65	𝕾.	75	F.	85	Th.
66	M.	76	Sat. 𝕾.	86	F.
67	Tu.	77	M.	87	Sat.
68	W. Th.	78	Tu.	88	𝕾. M.
69	F.	79	W.	89	Tu.

1690	W.	1700	M. Tu.	1710	𝕾.
91	Th.	1	W.	11	M.
92	F. Sat.	2	Th.	12	Tu. W.
93	𝕾.	3	F.	13	Th.
94	M.	4	Sat. 𝕾.	14	F.
95	Tu.	5	M.	15	Sat.
96	W. Th.	6	Tu.	16	𝕾. M.
97	F.	7	W.	17	Tu.
98	Sat.	8	Th. F.	18	W.
99	𝕾.	9	Sat.	19	Th.
1720	F. Sat.	1730	Th.	1740	Tu. W
21	𝕾.	31	F.	41	Th.
22	M.	32	Sat. 𝕾.	42	F.
23	Tu.	33	M.	43	Sat.
24	W. Th.	34	Tu.	44	𝕾. M
25	F.	35	W.	45	Tu.
26	Sat.	36	Th. F.	46	W.
27	𝕾.	37	Sat.	47	Th.
28	M. Tu.	38	𝕾.	48	F. Sat.
29	W.	39	M.	49	𝕾.
1750	M.	1760	Tu. W.	1770	M.
51	Tu.	61	Th.	71	Tu.
52	W. Th. 𝕾.	62	F.	72	W. Th.
53	M.	63	Sat.	73	F.
54	Tu.	64	𝕾. M.	74	Sat.
55	W.	65	Tu.	75	𝕾.
56	Th. F.	66	W.	76	M. Tu.
57	Sat.	67	Th.	77	W.
58	𝕾.	68	F. Sat.	78	Th.
59	M.	69	𝕾.	79	F.
1780	Sat. 𝕾.	1790	F.	1800	W.
81	M.	91	Sat.		
82	Tu.	92	𝕾. M.		
83	W.	93	Tu.		
84	Th. F.	94	W.		
85	Sat.	95	Th.		
86	𝕾.	96	F. Sat.		
87	M.	97	𝕾.		
88	Tu. W.	98	M.		
89	Th.	99	Tu.		

. . . .

1752

Sept.		Sept.		Oct.	
Tu.	1	Th.	21	𝕾.	1
W.	2	F.	22		
Th.	14	Sat.	23		
F.	15	𝕾.	24		
Sat.	16	M.	25		
𝕾.	17	Tu.	26		
M.	18	W.	27		
Tu.	19	Th.	28		
W.	20	F.	29		
		Sat.	30		

Table C.

BEFORE THE ALTERATION.

1700	M.	1100	S.
1600	Tu.	1000	M.
1500	W.	900	Tu.
1400	Th.	800	W.
1300	F.	700	Th.
1200	Sat.	600	F.

AFTER THE ALTERATION.

1800	W.
1900	M.
2000	Sat.
2100	F.
2200	W.

INSTRUCTIONS.

THE LUNERAL.

C		*6°*		*7*	*8*	*9*			**UNITS**
		0	*1*	*2°*		*3*	*4*	*5*	
b	a	5	6	7	8°		9		
		0°		1	2	3	4°		
4°	3	B	C	D	G	P	T	V	May.
3°		C	D	G	P	T	V	B	Jan. Oct.
2°	2	D	G	P	T	V	B	C	April. July.
1°		G	P	T	V	B	C	D	Sept. Dec.
0°	1	P	T	V	B	C	D	G	June.
6°		T	V	B	C	D	G	P	Feb. Mar. Nov.
5°	0°	V	B	C	D	G	P	T	Aug.
1752			40°	80°		20°	60°		**TENS**
		50	*90*		*30*	*70*		*10*	
(7)	(4)								

This table shows the date of the first Sunday in any month of any given year, from the year of our Lord till a fresh alteration is made in the calendar.*

In the right hand column are found the months of the year, and all the letters in the square stand for Sundays. Find the letter for the given year by the numbers which stand round the letters—see Rule,—and find *the same letter* opposite the given month: the number of places this letter is removed from the given month indicates the day of that month on which the first Sunday falls, that is to say, the date of the first Sunday. For example, if the letter for the given year were found to be **G**, the first Sunday in May of that year would fall on the 4th, as **G** is found opposite that month four places removed; in January and October the first Sunday would fall on the 5th; in April and July on the 6th; in September and December on the 7th; in June on the 1st; in February, March, and November, on the 2nd; and in August on the 3rd.

The sign "°" signifies Leap Year: and after February in Leap Year, the next letter to the right of that found for the year must be used for the rest of that year.

Rule.

To find the Letter for any given Year.

Note.—Divide the given year into centuries, tens, and units, as 1615 = 16 centuries, 1 ten = 10, 5 units: and find the centuries under **C**, † the tens opposite **TENS**, and the units opposite **UNITS**.

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* The calendar was altered in 1752 by the omission of eleven days, viz., from Thursday, 3rd September, till Sunday, 13th, inclusive; and by making no other centurial years Leap Year than those which are divisible by 400.

† **b** under **C** means before the alteration in the calendar, **a** after.

Divide the given centuries by 7 before the alteration in the calendar, and find the remainder under C b; or divide by 4 after the alteration, and find the remainder under C a: the letter *next* opposite the remainder and in the left hand column of letters is the letter for the given centuries.* In a line drawn from this letter to the opposite letter in the right hand column, and over the given tens, is found the letter for the given tens. Find the same letter in the left hand column. In a line drawn from this letter to the opposite letter in the right hand column, and under the given units,† is found the letter for the given units, *i.e.*, for the given year.

The number of places this letter is removed from the given month, in the same line as the month, indicates the day of the month on which the first Sunday falls.

EXAMPLES.

1066. *William the Conqueror crowned Monday, Christmas Day.*

Divide 10 by 7, and find the remainder, 3°, under C b, and opposite C. In a line drawn from C to the opposite letter B in the right hand column, and over 60, is found V. Find V in the left hand column. In a line drawn from V to the opposite letter T in the right hand column, and under 6 is found B, which is the letter for 1066. As B is found opposite December three places removed, the first Sunday in that month fell on the the 3rd, and the second would fall on the 10th, the third on the 17th, the fourth on the 24th, and the following day would be Monday, the 25th.

1815. *Battle of Waterloo, Sunday, 18th June.*

Divide 18 by 4, and find the remainder, 2, under C a, and opposite D. In a line drawn from D to the opposite letter C in the right hand column, and over 10, is found C. Find C in the left hand column. In a line drawn from C to the opposite letter B in the right hand column, and under 5 (in the upper group of units), is found B, which is the letter for 1815. B is found opposite June four places removed, and the first Sunday in that month fell on the 4th, the second on the 11th, and the third on the 18th.

Christopher Columbus sailed Friday, 3rd August, 1492.

NOTE.—T is the letter for the year 0, as 4 was the first Leap Year; the letters for 1752 are G. for Jan. and Feb., P. from 1st March till 2nd Sept. inclusive, and B for the rest of the year.

* 3, 2, 1 under **C a** take the next letter but one opposite the remainder. Before the year 700, take the number of the century: when there are no centuries take **O.**

† Use the upper group of units, when the tens are in italics.

9.—AN AUSTRALIAN FEDERAL DEBT.

By JAMES J. FENTON, F.S.S., *of the Government Statist's Office, Victoria.*

Now that there is a fair prospect of the establishment in the near future of an Australian Federal Union, not in name only, but with all the powers, responsibilities, and functions of an active Government, this is perhaps an opportune time to discuss the bearing of some of the financial aspects of that

Union, and I propose to deal with the important question of "Public Debt."

It has been suggested that, in the event of Federation the whole of the Public Debts of the Australian Colonies should be taken over bodily by the Federal Government and treated as a national affair; but a little consideration will probably lead to the conclusion that such a step is not only imprudent, but impolitic from an economic point of view.

From a perusal of the draft bill "To constitute the Commonwealth of Australia," recently adopted by the National Australasian Convention held in Sydney in 1891, one may form an adequate idea of the powers to be handed over to, and of the functions to be performed by, the Federal Government. Amongst a list of 31 matters enumerated in the Bill, which it is proposed should be provided for by federal legislation, perhaps the following are the more important from a financial point of view, viz., trade and commerce, customs and excise bounties, borrowing money, postal and telegraphic services, defences, navigation and shipping, &c., the control of railways with respect to transport for the purposes of the commonwealth.

From this it will be seen that the customs will form the main source of general revenue, the balance left after payment of expenses being returned to the subsidiary governments. It is however, not proposed, except temporarily in case of special emergency (such as transport of troops on railways in time of invasion), to take over, nor is it likely the different colonies would part with, the control of the railways, waterworks, and other public works of a reproductive character, for which the public debts were mainly incurred. This being the case, it is unreasonable to expect the Federal Government to render itself responsible for such works—over which it could exercise no control and from which it would derive no income. And considering that the works to be handed over are of comparatively small financial importance, the question naturally arises, in what manner the several colonies might, either with or without the assistance of the Federal Government, succeed in obtaining further funds for their necessary reproductive works in the best and most economical manner possible?

In order to deal adequately with this question, it will be necessary first to review the present condition of the Australian Public Debt; its past and probable future growth and present prospects; the purposes for which contracted; the present rates of interest; and the dates of repayment.

It may here be mentioned that the term "Australian" is intended to include Tasmania but to exclude New Zealand, as the latter colony, although represented at the Convention, has evidently no immediate intention of joining the proposed commonwealth. The debt of that colony, which at the end of 1890 amounted to £38,832,350, is therefore omitted from my calculations.

At the end of 1890 the aggregate Australian Public Debts stood at a little over 143½ millions sterling, or over £45 per head. More than three-fifths of the total amount has been borrowed by Victoria and New South Wales; but in proportion to population by far the largest borrowers are Queensland and South Australia, with about £72 and £64 per head respectively, whilst the most moderate borrowers are Western Australia and Victoria, with £28 and £37 per head. The following are the figures, which are exclusive of temporary treasury bills in aid of revenne:—

Public Debts of Australian Colonies at 31*st December,* 1890, *exclusive of New Zealand.*

	Debt.	Amount per Head.		
	£	£	*s.*	*d.*
Victoria	41,443,216	36	11	5
New South Wales	46,051,449	41	1	0
Queensland	28,105,684	71	17	4
South Australia	20,401,500	63	18	6
Western Australia	1,367,444	27	15	10
Tasmania	6,292,800	43	6	3
Total	£143,662,093	£45	9	3

So rapid has been the growth of the Australian Public Debt to the present amount, it is not to be wondered that the question should be attracting considerable notice at the antipodes; for in a period of only 20 years it has increased from 28 to 144 millions. This growth has been far in advance of that of population, the debt per head at the commencement of that period (1870) being only £17 as compared with over £45 in 1890. This will be seen by the following figures, which show the Australian indebtedness for every tenth year from 1860, also for the two latest years:—

Australian Indebtedness, 1860 *to* 1890.

	Amount.	Average per Head.
	£	£ s. d.
1860................	9,050,235	7 18 7
1870................	28,328,580	17 3 5
1880................	61,327,018	27 3 9
1889................	136,680,958	43 16 2
1890................	143,662,093	45 9 3

It will be observed that in the decade ended with 1880 the debt increased by 33 millions, or at the rate of $3\frac{1}{3}$ millions per annum, whilst during the last ten years it increased by $82\frac{1}{3}$ millions, or at the rate of $8\frac{1}{4}$ millions per annum. Of late years, however, the amount has only slightly exceeded 7 millions annually. This of course is exclusive of redemption loans. It might be observed that the colonies could at present borrow $4\frac{1}{4}$ millions per annum without increasing the amount per head.

The debt has certainly increased at a far greater rate than population, and much prominence has been given to this fact in England; but it must be remembered that it is only in recent years that the colonies have launched out upon the construction of public works on an extensive scale, which certainly appears justifiable from the remunerative nature and high economic value of such works, and the low terms on which the colonies have been able to borrow. The comparison with population, moreover, whilst it serves some useful purposes is apt to give an erroneous impression of the financial aspect of the question. A debt of £40 or £50 per head would certainly be alarming if there were nothing tangible to show for it, as in the case of the British public debt; but when amply secured, as it evidently is, by unquestionable securities, the realisation of which would go far to liquidate the whole liability, all cause for alarm at once vanishes, and full confidence is restored.

In fact, it is in this respect that the Australian debts differ essentially from those of other countries,—being raised as capital for the construction of public works to aid in the development of the material resources of these colonies. It is true that the net revenue from such works is in some cases insufficient to defray the whole of the interest; but then this is always the case with new undertakings, and moreover,

Government reproductive works—such as railways—are not expected to do this at first, especially when their construction is made in advance of population, but the immense advantages thereby accruing are reaped by the people who are not only able and ready to pay, but as a matter of fact do pay, the annual deficiencies as they arise, either by direct or indirect taxation, and not, as is sometimes the case, by charging them to the capital account.

A considerable portion of every sum lent to these colonies, moreover, finds its way back almost immediately—being converted into stock and material of British manufacture for the construction of the works for which borrowed, and thus not only stimulates the industry and trade of the United Kingdom itself, but at the same time tends to more closely cement the commercial and social interests of the British Empire. This is an important factor at the present time, seeing that certain foreign powers are striving hard to divert the current of British Colonial trade into other channels. Such loans also stimulate industry in the colonies themselves, not only by assisting to develop undertakings already started, but also by opening up new fields of enterprise, and by affording immediate occupation to the numerous immigrants who flock to their shores, and have not yet settled into suitable and permanent occupations. Without such assistance private enterprise alone in the earlier days of a colony's history would make but slow progress—hampered as it always is by the numerous obstacles incident to colonisation.

Still the borrowing should be devoted as far as possible to necessary reproductive works, and well regulated in order to absorb no more employés than could be continuously engaged. Otherwise it would have the pernicious effect of alternately depleting and inundating the ranks of those following the more settled occupations, resulting in undue competition or fluctuations in the labour market, and so unsettling and demoralising the working classes of the community.

The purposes for which the Australian debt at the end of 1890 was borrowed, together with the amounts under each head, are as follow :—

Australian Public Debt, 1890.—*Purposes for which incurred.*

Debt incurred for.	Amount.	Percentage.
	£	
Works yielding direct revenue—		
Railways and Tramways	96,617,873	69·4
Electric Telegraphs	2,727,610	2·0
Water Supply, &c.	14,721,961	10·6
Harbours, Rivers, Lighthouses, and Docks	8,446,162	6·1
Total	122,513,606	88·1
Other works of permanent utility—		
Roads and Bridges	3,065,696	2·2
Defence Works	1,487,678	1·1
State School Buildings	2,055,191	1·5
Other Public Works	5,233,780	3·7
Total	11,842,345	8·5
Miscellaneous—		
Immigration	3,497,419	2·5
Other Services	1,287,280	0·9
Total Debt apportioned	139,140,650	100·0
Ditto unapportioned *	4,521,443	
Grand Total	£143,662,093	

* Chiefly unexpended.

By these figures it will be seen that nearly seven-tenths of the debt has been devoted to railways alone, and nearly nine-tenths to railways, telegraphs, water, and harbour works—all of a reproductive character; whilst the balance has been chiefly applied to works of considerable national importance, although not yielding a direct return, such as roads, defence works, state schools, and other public works and buildings.

About six-tenths of the public debt bears interest at 4 per cent., not quite three-tenths at $3\frac{1}{2}$ per cent., and the remainder at rates varying from $4\frac{1}{2}$ to 6 per cent., whilst the average rate for the whole is slightly over 4 per cent., as may be ascertained from the subjoined figures:—

Rates of Interest on Public Debt.

Rate.	Amount at each Rate.
	£
6 per cent	4,796,350
5 "	9,546,160
$4\frac{3}{4}$ "	151,880
$4\frac{1}{2}$ "	5,340,150
4 "	85,117,719
$3\frac{1}{2}$ "	38,709,834
Total Debt	£143,662,093
Annual Interest at 31st December, 1890	£5,772,160 = 4·02 °/°

The whole of this interest, however, did not accrue during the year 1890, as the debt increased by about £7,000,000 in the twelve months, and there were balances unexpended in the banks which bore interest; but, assuming that £245,000 (being interest at $3\frac{1}{2}$ per cent. on the £7,000,000) was a sufficient allowance, the balance that accrued during the year was about £5,527,000. Towards the liquidation of this amount £2,720,000 was derived from the working of State railways after payment of all expenses, and probably £500,000 from water and other reproductive works—the actual net receipts therefrom in Victoria alone being nearly £219,000—leaving a balance of nearly £2,310,000 to be provided for from taxation, surplus land revenue, and other sources of general revenue. Thus, as much as 42 per cent. of the interest for 1890 had to be so provided for. If the Federal Government contemplated taking the debts over bodily, this would be a matter which would require careful consideration.

Estimating the value of the reproductive loan works from the net revenue actually obtained, we arrive at another aspect of the question. Capitalised at $2\frac{1}{2}$ per cent., the revenue of £3,220,000 from railways and other reproductive works would show their value to be close on £130,000,000, or within $13\frac{3}{4}$ millions of the whole debt.

This capitalisation is believed to be within the mark, considering, first, the probability of a fall in the rate of interest from about $3\frac{1}{2}$ per cent., which has recently prevailed, to eventually 3 per cent.; and secondly, the value to a syndicate or company if the works were sold. In the latter case a small increase in the present low rates, which it is the policy of the Government to maintain, and a saving in the working expenses by reason of the strict economy which would ensue,

would probably soon result in the realisation of a profit on the capital cost. The policy of the Australian Governments has always been to lower the rates as soon as the net revenue is more than sufficient to pay interest on loans; and in accordance therewith, the remission of railway freights by the Victorian Government alone during the last eight or nine years is equivalent to at least £200,000 per annum, or about 66 per cent. of the capital cost. This aspect of the case indicates that the assets are substantially sound, although a large proportion of the interest has, under existing conditions, to be provided for by taxation.

I have had some difficulty in tabulating on a uniform basis the amounts of loans repayable in the different colonies from the present time until 1940, when it appears the last portion of the existing debts is repayable. Some of the loans are repayable at fixed dates, others by annual instalments, and some are redeemable only at the option of the Government. This information is embodied in the following table, which shows as nearly as possible the amounts repayable in each quinquennial period, commencing with 1891:—

Australian Public Loans on 31st December, 1890, Repayable in Quinquennial Periods.

Period.	Victoria.	N.S.W.	Queensland.	S. Australia.	W. Australia.	Tasmania.	TOTAL.
	£	£	£	£	£	£	£
1891–4*	3,299,900	2,161,260	1,170,950	298,800	...	671,730	7,602,640
1895–9	2,686,316†	2,350,100	765,600	1,461,100	...	362,600	7,625,716
1900–4	8,457,000	3,780,500	...	319,800	103,900	194,820	12,856,020
1905–9	6,000,000	3,576,700	...	6,221,300	24,400	310,500	16,132,900
1910–4	4,000,000	2,963,700	1,466,500	295,600	...	2,346,650	11,072,450
1915–9	4,000,000	7,000,000	11,728,800	4,867,000	...	...	27,595,800
1920–4	13,000,000	16,500,000	12,973,834	1,677,300	...	300,000	44,451,134
1925–9	...	...	...	200,000	...	...	200,000
1930–4	...	7,186,300	...	...	938,844	...	8,125,144
1935–40‡	...	...	...	1,317,800	...	2,106,500	3,424,300
Annual drawings	...	Distributed	...	3,742,800§	300,300‖	...	4,043,100
No fixed date	...	532,889	...	...	...	...	532,889
Total	41,443,216	46,051,449	28,105,684	20,401,500	1,367,444	6,292,800	143,662,093

NOTE.—The amounts are exclusive of temporary Treasury Bills in aid of revenue, as follows:—New South Wales, £2,373,883; South Australia, £750,000; Tasmania, £140,000.

* Four years. † Of this amount £1,032,416 is redeemable (in 1897) only at option of the Government. ‡ Six years.
§ Between 1916 and 1936. ‖ In 1891 and subsequent years.

The long currency of many large loans in some of the colonies as shown in the table is very striking. Thus in Victoria, whilst one-half is repayable within 19 years, one-third will remain outstanding until between the 30th and 34th years; in New South Wales, whilst one-half is to be redeemed within 29 years, one-third is not due until between 29 and 34 years, and one-sixth not until after 39 years; in Queensland nearly the whole is repayable from 25 to 35 years hence; in Western Australia the bulk is not due until after the 39th year; and in Tasmania more than one-third is redeemable between the 20th and 24th years, and the final third not until between 45 and 49 years. Taking the colonies as a whole, about $10\frac{1}{2}$ per cent. of the existing debt is repayable before 1900; 28 per cent. between 1900 and 1915; 19 per cent. between 1915 and 1920; and 31 per cent. between 1920 and 1924; the balance being repayable either after that date, by annual drawings, or at some indefinite period.

The great loss which results to the colonies from such distant periods of repayment, combined with the great unexpected fall in the rate of interest at which they can borrow, may be exemplified by a few examples. Thus New South Wales has to pay interest on £16,500,000 raised in the years 1884–6 at the equivalent rate of £3 17*s.* 8*d.* (real interest) for 33 years more, and on about seven millions raised in 1883, at the rate of 4 per cent. for 42 years more, whereas the money could a few years afterwards be obtained for about £3 8*s.* 6*d.* per cent., and will probably be obtainable in the near future at little more than 3 per cent. In like manner Queensland has to pay over 4 per cent. on nearly eight millions raised in the years 1884–7 for 33 years, whereas in 1888–90 that colony had to pay only about $3\frac{3}{4}$ per cent.

Such facts as these should impress on the various colonies the urgent necessity of shortening considerably the currency of their loans; or, better still, of issuing permanent loans repayable at option of the colonies after a fixed date, either with a uniform rate of interest, or—as in the case of the New British Consols (Goshen's)—with a gradually reduced rate of interest after certain fixed intervals of, say, 15 years, down to 3 per cent. This method, moreover, will save the necessity, inconvenience, and expense of floating redemption loans. I am aware that these suggestions are not new, but they are of very great importance, and cannot be too prominently brought under the notice of the various Australian Governments.

This completes the review of the present aspect and condition of the Australian Public Debts, and now I must revert to the immediate object of my paper.

From a glance at the figures already given detailing the purposes for which the Australian Public Debts were raised, it will be noticed that only about £10,000,000 is what would legitimately fall to the share of a Federal Government, *i.e.*, assuming that the defence works and customs were entrusted to its care; but the great bulk of the debt—134 millions—being contracted for provincial or local public works, must still be looked upon as liabilities appertaining to the several provinces.

The following is a division of the Australian Public Debt into Federal Debt and Provincial Debt on this principle :—

Australian Public Debt.

	£
Contracted for Federal purposes—	
Defence Works	1,487,678
Harbours, Rivers, &c.	8,446,162
Total	9,943,840
For Provincial purposes	
Railways and other Public Works	133,718,253
Grand Total	£143,662,093

Assuming, then, that this division be approved of, and a federation established, it is clear that the 10 millions might without demur be at once taken over by the Federal Government on conversion into a uniform Australian stock, bearing at first about $3\frac{1}{4}$ per cent., but eventually 3 per cent. interest. Such conversion could undoubtedly be effected on terms most favourable to the colonies, in view of the larger security offered, and the uniformity and stability, and hence increased marketability, of an Australian federal stock. The Federal Government, moreover, would probably be in a position within certain limits to demand its own terms for conversion.

As regards the 134 millions borrowed for local purposes, I would propose that such portions of that amount as were borrowed for strictly reproductive works, and as the Federal Government may consider amply secured, might also be taken over on the security of such works, and on such other terms and conditions as it might deem necessary or expedient in order to insure the regular payment of interest and expenses by the various colonies interested. Such loans might also

be converted into the Australian stock alluded to, and be known locally as the Federal Local Loans Stock. It should be distinctly understood, however, that whilst the several colonies thus make themselves jointly and severally liable for mutual benefit, each colony must provide adequate security for the actual amount borrowed from this stock on its own account.

Each colony could thus obtain a supply of money for its local reproductive works on the lowest possible terms, and instead of each colony floating a series of petty loans on its own separate account, the colonies would in regard to future borrowing present a united front in London, with one large uniform Australian Stock. Moreover the careful scrutiny which would of necessity have to be exercised by the Federal Government before granting a loan for local purposes, which would practically render the several states jointly and severally liable, would tend to restrict the money borrowed to works of a strictly reproductive character, and so raise the status of an Australian Stock that it may eventually take precedence, after British Consols, over all other public securities.

As regards the form which a Federal Stock should take, it is considered that, after the present depression prevailing in London—arising from the crisis in South American States—has passed away, there would be no difficulty in obtaining par for a $3\frac{1}{4}$ per cent. Australian Federal Stock. If this be the case, then a permanent stock might be created bearing interest at that rate, but redeemable at the option of the Government after a period of say 15 years, so as to derive any advantage that might then or thereafter accrue from a fall in the rate of interest, as may be anticipated to 3 per cent. The interest on the stock should all be payable quarterly, either at the beginning, or preferably at the end, of each quarter. Hitherto interest has usually been payable half-yearly, but this either resulted in great inconvenience by having to remit large amounts of interest at one time, or necessitated the issue of two separate stocks with interest payments alternating quarterly, which destroyed the uniformity and thus depreciated the values of the several stocks. It may be mentioned that a change from half-yearly to quarterly interest payments was made in converting the old British 3 per cent. consols into $2\frac{3}{4}$ per cents. The object of paying the interest at the end instead of at the beginning of each quarter is to make the interest *payable* during any year identical with the interest *accrued*—an advantage which is obvious, for at present there

are anomalous differences in those items in the Financial Statements of most of the colonies.

But even without federation much might be done to improve the status of Australian securities, not only by each colony gradually converting, as opportunity offers, its numerous petty loans into one consolidated stock, but by all the colonies agreeing to one uniform rate of interest, uniform dates for payment of interest, and a uniform currency. By this means not only would the book-keeping be greatly simplified, but the marketability and consequently the value of all the stocks would be considerably increased. The advantages of a uniform stock seem to have been strangely overlooked by all the colonies, whose debts for the most part consist of a host of petty amounts differing either in the rate of interest, the date of repayment, the periods of interest payments, or in the form of the security itself (whether of debentures or stock). Thus it happens that an investor cannot exchange one parcel of stock for another of the same colony, or increase his holdings, without taking all these confusing details into consideration; and he is still further hampered in dealing with the stocks of two or more colonies. Glancing at a list of the loans of Victoria, for example, it is found that, out of a total of £41,443,216, the largest amount that has a uniform currency and rate of interest is only £7,000,000; and out of a total of £46,051,449 of those of New South Wales, only £16,500,000 has similar uniformity.

There are other matters which cannot be dealt with in this paper, such as the establishment of a Joint Australian Loan Department in London (such as has before been suggested), to manage all affairs connected with the issue of loans and payment of interest. In connection with this, the cost of terminating existing agreements would of course have to be considered.

In the preparation of this paper I have to acknowledge my indebtedness to the "Australasian Statistics, 1891," compiled by Mr. Hayter, Government Statist of Victoria, and to the Financial Statistics embodied in the "Year Book of Australia," published by Mr. E. Greville, of Sydney.

10.—INSANITY AND CRIME.

By E. PARIS NESBITT.

The questions to which I desire to call your attention relate partly to law and partly to medical science.

They form, indeed, a debatable ground on which lawyers and doctors have from time to time fought with an energy not unseasoned with acrimony, the latter being perhaps more noticeable on the part of the medical profession. Dr. Maudsley, in particular, speaks in the preface to his work on "Responsibility in Mental Disease," of "the scorn and indignation felt by those who observe with impatience the obstinate prejudice with which English judges hold to an absurd dictum which has long been discredited by medical science, has been condemned in the severest terms by judicial authority in America, and has been abandoned in other countries." He refers here to a doctrine affecting the legal responsibility under the Criminal Law of England of persons afflicted with mental disease. I hope to be able to show that the doctrine as stated by Dr. Maudsley is by no means so well established or so obstinately held as he seems to think, and that the law of England, though not as clear as it might be, is, at all events, in a sufficiently fluid condition to allow of its being formulated into a shape consistent with the best knowledge and wisdom derivable from the opinions of those who have made lunacy their special study. These remarks apply only to the substantive law which regulates the responsibility of offenders. So far as regards the treatment of criminals on the borderland between sanity and insanity, or who from hereditary or inherent vicious tendencies are incapable of reformation by ordinary punitive measures, there is still much to be desired. Signs are not wanting, however, that methods more humane and enlightened than those hitherto in use will before long be resorted to in such cases.

In the observations I have to make upon the responsibility of insane persons under the Criminal Law, I speak simply as a lawyer and a jurist—as one who has studied the law as actually existing, and who has considered in what direction and to what effect it requires further definition and improvement. From the point of view afforded by medical knowledge pure and simple I have little or nothing to say. Though the proverbial differences of doctors are displayed in this no less than in other fields of their science, there is sufficient broad general agreement among them to give to those who have

the making and those who have the administration of our laws light enough to guide them to such principles of action, imperfect at the best, as are consistent with our present social state.

The law of England, as to the effect of madness on criminality, is stated as follows in Sir James Stephen's Digest of the Criminal Law:—

"No act is a crime if the person who does it is at the time when it is done prevented [either by defective mental power, or] by any disease affecting his mind.

"(*a*) From knowing the nature and quality of his act, or

"(*b*) From knowing that the act is wrong[1] [or

"(*c*) From controlling his own conduct, unless the absence of the power of control has been produced by his own default.

"But an act may be a crime although the mind of the person who does it is affected by disease, if such disease does not in fact produce upon his mind one or other of the effects above mentioned in reference to that act."

Illustrations.

"(1.) A kills B under an insane delusion that he is breaking a jar. A's act is not a crime.

"(2.) A kills B knowing that he is killing B, and knowing that it is wrong to kill B, but his mind is so imbecile that he is unable to form such an estimate of the nature and consequences of his act as a person of ordinary intelligence would form. A's act is not a crime if the words within the first set of brackets are law. If they are not, it is.

"(3.) A kills B knowing that he is killing B, and knowing that it is illegal to kill B, but under an insane delusion that the salvation of the human race will be obtained by his execution for the murder of B, and that God has commanded him (A) to produce that result by those means. A's act is a crime if the word 'wrong' means illegal. It is not a crime if the word 'wrong' means morally wrong.

"(4.) A suddenly stabs B under the influence of an impulse caused by disease, and of such a nature that nothing short of the mechanical restraint of A's hand would have prevented the stab. A's act is a crime if (*c*) is not law. It is not a crime if (*c*) is law.

"(5.) A suddenly stabs B under the influence of an impulse

[1] Variously interpreted as meaning *morally wrong* and *illegal.*

caused by disease, and of such a nature that a strong motive, as for instance the fear of his own immediate death, would have prevented the act. A's act is a crime whether (*c*) is or is not law.

"(6.) A permits his mind to dwell upon and desire B's death; under the influence of mental disease this desire becomes uncontrollable, and A kills B. A's act is a crime whether (*c*) is or is not law.

"(7.) A a patient in a lunatic asylum, who is under a delusion that his finger is made of glass, poisons one of the attendants out of revenge for his treatment, and it is shown that the delusion had no connection with the act. A's act is a crime."

You will perceive that the learned author from whom I have quoted leaves it in doubt whether the want of the power of self control, such want being caused by defective mental power or by disease of the mind, does or does not absolve the person committing an act from responsibility to the Criminal Law, and, in his History of the Criminal Law (vol. ii, p. 150), he says that although some of the terms in which the law is expressed are well settled, their meaning and the manner in which they ought to be applied to certain combinations of facts are not settled at all. This uncertain state of the law, in which even a jurist of the highest eminence and a judge (until recently) of the High Court of Justice, England, is unable to define with completeness and precision the law upon the subject which we are now considering, is not creditable to English jurisprudence. It arises from the fact that, except where the legislature interposes with an authoritative amendment or declaration, the law has to be settled from time to time by the judges who hear particular cases, and who give their judgment (*a*) according to statute or precedent, or both combined, and (*b*) where these are wanting or fall short, according to their own ideas of "right and justice and the natural reason of the thing." The consequence is that, though the law is thus endowed with an admirable elasticity and power of shaping itself to the changing conditions of society, it is left uncertain in all cases not provided for by statute or covered by authority.

This question of criminal responsibility where the power of self control is absent, is one upon which medical men feel strongly. Dr. Maudsley says (Preface to Responsibility in Mental Disease, p. vii.)—" It is a matter of common obser-

vation, which hardly any one who has practical knowledge of insanity would dispute, that there are very few lunatics who do not know what they are doing when they do insane acts, and it is an elementary truth of psychology, although English judges seem not to be aware of it, that the impulses to action, sane or insane, come not from the intellect, but from the affective nature. To hold an insane person responsible for not controlling an insane impulse of the nature of which he is conscious is in some cases just as false in doctrine and as cruel in practice as it would be to hold a man who is convulsed by strychnia responsible for not stopping the convulsions because he is all the while quite conscious of them."

Dr Maudsley proceeds to cite a case in which Mr. Justice Brett told the jury that "it was not enough to show that a man was mad or had what medical men called an 'uncontrollable impulse,' for, even assuming this, the law did not absolve him from the consequences of his act. He knew what he was doing, and if he knew that it was wrong then he was responsible for it. That had been declared to the House of Lords by the Judges of England many years ago, and by the law so declared judges and juries were equally bound."

The learned Judge refers here to the answers given by the Judges of England to questions put to them by the House of Lords in 1842 upon the subject of insane delusions, and their effect upon the criminal responsibility of persons subject to them. These answers are carefully considered by Sir James Stephen, and he thus expresses the conclusion at which he arrives (p. 183):—

"The question, 'What are the mental elements of responsibility?' is, and must be, a legal question. It cannot be anything else, for the meaning of responsibility is liability to punishment; and if criminal law does not determine who are to be punished under given circumstances, it determines nothing.

"I believe that by the existing law of England those elements (so far as madness is concerned) are knowledge that an act is wrong, and power to abstain from doing it; and I think it is the province of judges to declare and explain this to the jury."

Although this expression of opinion on the part of Sir James Stephen is not of course binding on any other judge, yet the weight attaching to it is so great, and is so conformable to common sense and to the principles which ought

to regulate criminal jurisprudence, that I have little doubt, should the points to which it relates come before a Superior Court in any of the British dominions for consideration in Banco, they will be decided in accordance with Sir James Stephen's views. How closely these approximate on this matter to those of Dr. Maudsley appears on comparing them with the following extract from the preface to the work of that gentleman which I have already quoted. He says (pp. v. and vi.)—"The writer" (of an article in the *Pall Mall Gazette*) "does not in his consideration of the criticism which I have ventured to make upon the legal criterion of responsibility defend it as it stands at present; he would not, however, supersede it, but would make an addition to it, by including in the judicial statement *from to do or to abstain from doing an act* as well as knowledge of the nature and quality of the act. But therein lies the essence of the dispute; that once granted, nothing more need be asked, and there would be an instant end of the battle."

As Sir James Stephen made a careful study of Dr. Maudsley's work before writing his own, the latter gentleman may, I think, be fairly credited with having helped to elicit from a legal authority of the highest eminence an elucidation of the law which will probably have the effect of causing judges in their charges to juries to give more prominence to the importance of ascertaining the presence or absence of the power of self-control than they had previously done, and to direct them, where they find that by reason of mental disease the prisoner could not control his action, to find a verdict of not guilty on the ground of insanity.

And when we consider what is the true basis of the right of the community to punish for crimes, the existence of the power of self-control appears to be absolutely essential to criminal responsibility. In my opinion this right rests entirely upon the right of the community to protect itself. It is impossible for the law or its ministers to award punishment according to the moral guilt of the offender. To say nothing of the old and interminable controversy on the question whether there is such a thing as free will at all, it cannot be denied that hereditary temperament, circumstances, and education have a most important bearing upon the moral guilt of offenders, which yet cannot be estimated with any approach to precision. No doubt the judge who sentences a prisoner is sometimes more reprehensible in his whole life from a moral point of view than the poor wretch whom he

condemns. These considerations cannot be allowed to interfere with the execution of the criminal law, but I think they should be taken into consideration in our attitude and feelings towards those unfortunate persons who are subjected to its operation. The eminent lawyer to whom I have so frequently referred thinks that hatred of criminals is justifiable and right, and that the importance of a proper hostility towards them has of late years been much under-estimated. (History of the Criminal Law, vol. 2, p. 91). In another portion of the same work the author (p. 179) quotes the following passage from a report addressed to the Commismissioners of Lunacy in 1854 by Dr. Bucknill and Dr. Luke :—

"The violent conduct of an insane patient is sometimes the expression of his normal state of mind and disposition. Violent and turbulent men supply their full share to the population of asylums. Sometimes the red hand is palsied by the taint of insanity. Sometimes the original disposition, and the power to express itself in dangerous acts, remains unchanged. Violence of this kind, resulting from a fierce and wicked disposition, might on first thoughts appear to justify the most direct and energetic measures of repression; but when we reflect how little the malevolent disposition of a sane man has been proved by the failure of all reformatory methods to be modifiable by any form of repression or punishment—when we reflect that punishment of any kind, even when most deserved, is entirely foreign to the beneficent calling of the medical men, we shall do right to conclude that it is enough to distinguish this form of violence from others which are the symptoms of disease, and to meet the dangers resulting from it by measures of precaution, while we strive to weaken the force of passionate and evil temper by that long-suffering charity which overcometh evil with good."

Sir James Stephen continues : "With the latter part of this extract I have no sympathy. It suggests that nobody should ever be punished at all. Reluctance to punish when punishment is needed seems to be to me not benevolence, but cowardice, and I think that the proper attitude of juries towards criminals is not long-suffering charity but open enmity; for the object of the criminal law is to overcome evil with evil."

The learned judge's state of mind on this subject reminds me of the country boy who was found beating a toad with a stick, saying "I'll larn thee to be a toad—I'll larn thee to be a toad;" when remonstrated with, he replied "But he war a

toad," and seemed to think this quite sufficient justification for his conduct.

While severity towards criminals cannot be dispensed with, and moral reprobation is a weighty instrument where the moral sense exists in its objects and is not altogether blunted, to feel hatred towards criminals seems to me utterly unworthy, and to show that those who entertain it have yet much progress to make. Between the hatred which Sir James Stephen justifies and the majestic serenity of the mind which, while detesting crime, can still regard the criminal as an erring and deeply unfortunate brother, the gulf is wide indeed. Can we doubt which is the most worthy of a high moral nature, and of a truly strong character?

There are other aspects of my subject which cannot be dealt with in the limits of this paper. But I wish to draw your attention to some remarks made by Mr. Justice Bundey in a paper recently read by him before the Adelaide branch of the Australian Natives' Association. His Honor's experience has led him to the conclusion in many cases where men are guilty of certain class of offence the act is one of the first open indications of insanity, and that the floggings and imprisonment to which they are subjected are under the circumstances not useless and unjustifiable. Dr. Strachan, in a paper read before the British Association for the Advancement of Science, about the same time as Mr. Justice Bundey's was read in Adelaide, expresses the opinion that the ordinary punishment of a great many criminals in England is absolutely useless as a preventive measure. He shows that a very large proportion (I have not the figures at hand) of the criminal class are convicted over and over again without the slightest deterrent effect, and holds that many of the offenders are more or less insane. He suggests special treatment in special institutions. Even if this resulted in lifelong imprisonment, in many cases it would appear to be more in accordance with rational principles than the course now adopted. It does not follow from the fact of insanity in any person that no punishment at all should be administered. Sir James Stephen suggests that juries should have the power of returning a verdict of "Guilty, but his power of self-control was diminished by insanity," and that a person so found guilty should in cases of murder be sentenced to penal servitude for life, or not less than say 14 years, and, in cases not capital, to any punishment which might be inflicted upon a sane man. He certainly does not err upon the side of mercy,

but there can be no doubt that the fear of punishment may, and in lunatic asylums constantly does, have great weight with insane persons. It is to be hoped that this matter may before long receive due attention from the Legislatures of the various Colonies. Meantime, I trust that its importance will be sufficient excuse for the time which I have occupied of the section.

11.—THE INCIDENCE OF TAXATION.

A SUMMARY OF A PAPER READ BY PRIDEAUX SELBY, ESQ., BEFORE THE INSTITUTE OF BANKERS, LONDON, 5TH DECEMBER, 1888.

WITH INTRODUCTORY REMARKS

BY

NICHOLAS J. BROWN, *Hobart*.

The students of Economic Science being desirous to promote harmony amongst the various members of the body politic, and to secure a just apportionment of the burden of contribution to State funds, their attention may be usefully directed to the consideration of the subject which forms the title of this paper, "The Incidence of Taxation."

There are few questions of general interest on which misunderstandings, and sometimes wilful misrepresentations, are so prevalent, and at the same time so mischievous to a community.

The problem being to provide the funds necessary for defraying the costs and charges of Government with the least possible inconvenience to those who have to contribute those funds, it is not surprising that in the effort to place the burden, or to *appear* to place the burden, in the common phrase, "on the shoulders of those best able to bear it," numerous expedients should be from time to time discussed, and supported with more or less ingenunity and persistence by those who advocate them. Popular applause, as we have seen frequently in the various Australasian Colonies, is easily secured by a loudly expressed determination to tax the so-called rich property owner, and to relieve the wage-earner. In times of political excitement the voices of those who analyse systems of taxation, and trace out the probable effects of any proposed impost before according to it their approval,

are drowned. If those possessing the preponderance of voting power can be persuaded that capital is going to be "got at,"—that those who undertake all the risk of providing the necessary means, and who must possess the skill and knowledge essential for the successful direction of industries are to be made to disgorge some of what are represented as their ill-gotten gains, then the success of the political adventurer who so persuades them is assured. Not by any means the least of the evils attending the controversies so raised is the bitter feeling of animosity between employer and employed which is thus engendered or intensified, and which almost hopelessly obscures the view of the mutual interest of capital and labour which we may trust will become more plain as the world grows wiser.

To an assemblage such as this, however, and possibly through it to the more thoughtful of all classes in Australasia, some words may be addressed which will help to promote the formation of views somewhat sounder than those which unhappily often prevail on this subject. It is often forgotten that when we speak of the cost of government we include charges for services which are placed freely, and on equal terms, at the disposal of every member of the community, whether poor or rich. Such, for instance, are the services rendered by an organised police force, and by all the machinery of law for the protection of life and property; the services rendered by post and telegraph offices and by railways, and by the provision made for elementary education, either free or at a merely nominal cost. While the cost of all these services falls proportionately on property or income, or both, yet there is no such proportion observed in regard to the rendering of the services to individuals. That is to say, for instance, if a rich man and a poorer man walking in the street together are assaulted, and sustain bodily injury, or are plundered, the whole machinery of police and of law is very properly available equally for the redress of the poorer as for that of the richer man, and for the punishment of his assailants. And as to services rendered by a railway or other state-maintained organisation, they are equally and on the same terms at the command of the man who has contributed to their cost and annual maintenance a sum representing perhaps not one-twentieth of his income, and the man who has contributed one-tenth or more of his income for the same purposes. And yet the service rendered may represent to the former, in facility for prosecuting his industry, or in the

saving of time and labour, a far higher value than to the latter.

But apart from considerations such as these, the fact which it appears more especially desirable to bring home to the minds of those interested is this, that, traced to its ultimate incidence, all taxation is paid by the producer who produces more than he requires for his own consumption, and that taxation laid upon the primary instrument of production, land, or on the income derived from land, does not only not ultimately relieve the wage-earning portion of the community, but, on the contrary, must have the opposite effect of diminishing the fund from which their wages are paid. It is not, of course, contended that land, or the income from land, should be relieved from taxation. They should bear their fair proportion, especially in these Australasian Colonies where so much of the State expenditure is devoted to providing facilities for communication and otherwise enhancing the capabilities of production. All that is desired is to help to dispel, if possible, some of the delusions as to the effects of such taxation which are encouraged, sometimes perhaps in good faith, but sometimes wilfully, and always mischievously.

These remarks are made by way of introducing to wider notice than perhaps it would otherwise obtain, a paper by Mr. Prideaux Selby, read by him some three years ago before the Institute of Bankers, London. The paper in itself will I believe be found to be an ample justification for my submitting it, in preference to any original production of my own, for your consideration. Before proceeding, however, I desire to guard myself by saying that while Mr. Selby's paper commends itself to me in the main as enforcing the views which I desire to have elucidated, yet there are a few propositions and some minor portions of the argument in which I do not altogether concur. But these do not affect the general conclusions.

Omitting some introductory remarks, Mr. Selby's paper may be summarised as follows:—

Man's progress, beyond merely animal existence, depends upon the extent to which he develops in his actions the qualities of industry, forethought, and thrift, and so soon as some recognise and act on this principle, while others do not, the distinction arises between rich and poor. The next stage in progress involves the principle of taxation; for the rich or thrifty man finding his own strength insufficient to defend his property from his less provident fellows, with a part of his

hoard buys assistance for the defence of the remainder. That is, he gives a part of the result of his industry to preserve the balance, and this is the essence of taxation, properly so-called. Taxation may be for providing police and military, for the protection of life and property, for education given in the hope that it will increase respect for the law, and thus reduce the cost of police, or that it will increase the productiveness of labour; or it may be for payment for the performance of the many functions of an administrative government, whereby the convenience, safety, and general well-being of the tax-payers are promoted. This taxation must come from the accumulations of past industry and thrift. A tax, then, may be defined as a part of the previously unconsumed, but consumable, products of industry and thrift relinquished by the owner to secure him in the enjoyment of the balance. It is contended that whatever diversities of form taxation may assume it will be found that in ultimate incidence every continuous tax, every tax levied by instalments over a long period of time, falls under this definition.

There is a general law as regards old taxes which renders unnecessary any consideration of the first of Adam Smith's famous maxims, that, namely, in which he requires that taxes be so imposed as to fall upon the several members of the community in proportion to their means. It is held that the total taxation continuously paid by any community forms a charge on production, and is deducted from the total product of the co-operation of labour and capital before the division of that product.

It is important, firstly, to establish the truth of this law, and to illustrate its practical operation; and, secondly, to show what an important bearing its recognition in practice would have upon the welfare of the working or wage-earning classes of the community.

Much consideration has been given by various writers on taxation to the arrangements necessary to provide for the observance of the fallacious axiom of Adam Smith, and for the adjustment of the balance between direct and indirect taxation. But that balance will adjust itself if legislative changes are abstained from. The incidence of a newly-imposed tax is quite different from that of an old tax nominally the same. Professor Nicholson says truly: "It has been found by experience that an old tax causes less inconvenience than a new tax of smaller amount, a fact which is so striking in some cases as to have given rise to the saying that an old

tax is no tax." But exception must be taken to the contention of Professor Nicholson and other writers who regard it as of prime importance, that great care should be taken that the real burden of a tax shall fall on those aimed at by the Legislature. Let us suppose, for example, a land tax is to be imposed upon all agricultural land. Land in England pays, or has redeemed, such a tax to the extent of 20 per cent. on what was once its value. As a new tax, such an impost diminishes the selling value of all agricultural land to the extent of the capitalised amount of the tax,—because investment in land is but one form among many for the investment of the savings of the community. The land will not bear a heavier rent because of the tax, so, other things being equal, the landlord must pay it out of the previous rental; and any new purchaser will expect such rental, reduced by the tax, to yield him the same percentage on his investment as was enjoyed, before the tax, by the then owner. The tax, then, although it has forfeited a part of the property of the original owner of the land, does not, if continued, fall on the new purchaser. Where does it fall? Obviously, on the produce of the land, just as rent does. In fact it becomes part of the "economic" rent, and as such, a charge on the produce of the land.

Or, consider a tax of another description—an import duty on tea which is not produced in England. To obtain the tea an English product must have been exported. That product, then, is indirectly, if not directly, the payment for the cost of the tea as landed before the payment of duty. To obtain the tea duty paid the consumer must, now that the duty is imposed, produce not only what the foreigner requires for the tea, but also what his own Government demands. That payment may be made in one case in kind and in the other in money is beside the question.

The only real taxpayer is, then, the producer who produces more than he himself consumes. The tax must be paid before he can enjoy the fruits of his industry. And as, according to economic law, the net profits of all industries tend to equality, a special charge laid on one industry will divert labour and capital from it to others not directly subject to the charge, thus gradually spreading it over all industries. The title of producer, however, must not be restricted to those who labour directly with hand or brain in the work of production. It includes all those who, in a wider sense, contribute to the harvest. It includes him who, by simple

abstinence, has provided the seed-corn, which he might have eaten, as truly as it includes him who ploughs the land that that seed may yield a sixty-fold return.

Taxation, therefore, affects only consumable commodities. It takes from industry a part of its reward. But it cannot or will not take such products of industry as are usually known as fixed capital. To take possession of fixed property and use it without compensation for the purposes of the government is not to tax, but to confiscate. It is important to notice, moreover, that the amount coming into the State treasury is no true measure of the taxation of any country: the real taxation is the amount of otherwise unproductive effort entailed upon the people by the Government; unproductive, that is, as regards the supply of their own wants. Compulsory military service, for instance, is an enormous tax upon the productive energies of any people, but it represents nothing in the State treasury. Taxation when excessive may drive capital from the country in the same manner that excessive local taxation drives capital from any locality; therefore, the producer of food and other consumable products of industry has thrown upon him the duty of distributing the burden of taxation between capital and labour under the laws which govern the distribution of all charges upon production.

We see, then, the fallacy of all proposals for redistributing taxation in the hope of ensuring that one class of the community shall not be unduly favoured at the expense of another or others. If taxes are levied directly on land they reduce the income of the landowner. They reduce his expenditure; and, to the extent to which they, being unproductively expended, reduce his productive expenditure, they reduce the ultimate wage fund.

If it is a new tax, the landowner must reduce his expenditure. He may dismiss a gardener who has worked in his pleasure grounds, or he may reduce his consumption of champagne and thus indirectly dismiss the factory hand, whose exportable work would have paid for the luxury. The State with his money finds employment in the dock-yards for the dismissed gardener or the factory hand—not probably in *propria persona*. The net result, then, is that the landowner has an enjoyment the less, but that the power of the country to maintain its population, alike during the current season and subsequently, remains unaffected. Very different will be the case should the landowner dismiss a ploughman

and grow less wheat, or reduce the supply of foreign manure to his land with the sam eeffect; or withhold his wonted contribution to the resources his banker lends for such purposes. Here, too, the tax may enable the Government to find work, directly or indirectly, for the discharged workman. But whence, next year, will come the food which his reproductive employment should have provided? The people will, next year, have less command of food. The landlord, too, though he will have enjoyed his pleasure grounds, or his champagne, as usual, will be deprived of the additional pleasures he could have purchased with the proceeds of the wheat he has been prevented from producing.

Bastiat in his short papers entitled, "That which is seen and that which is not seen," shows very clearly at what a tremendous cost to the world at large the individual indulges in prodigal—*i.e.*, unproductive—expenditure. In short, taxation, to the extent to which it diverts the current energies of the community from productive to unproductive work, in so far, that is, as it reduces the produce of the ensuing harvest, reduces the wage fund for the year following the harvest, that is, it reduces the future means of subsistence of the people; and it does so when directly levied from the rich or on land, not less than when levied on the poor or on commodities.

No one has disputed or will dispute that taxes should be certain and not arbitrary; but you will see that all changes in taxation infringe this rule. On first imposition, a new tax is always arbitrary. That taxes should be levied at a convenient time and in a convenient manner; and that they should take from the taxpayer as little as possible in excess of the net income to the State, are also maxims not open to question. A tax when first imposed can hardly fail to be an arbitrary and unfair imposition upon some one or more persons or classes to the exclusion of others. Time, perhaps many years, is required to adjust it to its true incidence. In like manner the removal of an old tax is a present to those directly affected at the expense of the general community. Hence arises constant agitation from those who think they can benefit themselves by obtaining some change in taxation. Hence, also, the intensity of dislike to new taxation by those on whom it directly falls. Abundant evidence of serious political results from these natural circumstances are given by Dowell in his very valuable work, "History of Taxation in England." But time adjusts all inequalities to the shoulders of the people, and it would be a great blessing if politicians

left taxation severely alone; to be content with existing taxes somewhat more than sufficient in ordinary times to pay the way of the Government; to reduce debt with any surplus, and to borrow for reasonable excess expenditure of an exceptional time. Great crises require special treatment, but our statesmen, not only of the present time, seek change for its own sake, and act as though the welfare of the country required every budget to be sensational. Very exceptional is the happy year which contributes nothing to the history of changes in taxation.

Bastiat has well shown that as capital increases in its proportion to available labour, its share of the joint produce, though actually increased, is relatively reduced, but that the share of labour is increased both actively and relatively. Peace and prosperity increase capital and increase the wage fund.

It will be found that the countries in which the revenue is raised directly from land or from property are those in which poverty is most widespread, and in which the working man has least the power of raising himself in the social scale. What we have to strive after is to reduce unproductive expenditure and increase the productive. Society is founded on industry, prudence, and thrift. Were these universal, poverty would soon disappear. Without them poverty would also be short-lived, for the human race would cease to exist. The struggle for existence, of which Darwin writes, affects man as well as brute; but man has thrift as an intellectual force guiding his conduct,—brutes merely as an instinct.

A word to the wealthy. Politicians must please their constituents, or as politicians they cease to exist. Men seek what they regard as their own interests. Their views are often short-sighted, but the politician who wishes to gain their votes must support their interests as they conceive them. Cannot means be devised for a propaganda amongst the masses to induce them to look beyond to-day in their own interests—to make them see that when law, this year, checks the profitable use of capital, the wage-earner of next year will have short commons? that early and improvident marriage amongst the working class is the true cause of low wages; that the sweater and the extortionate landlord are alike products of improvidence, and that to sacrifice the few rich to the immediate necessities of the poor is but to eat the seed from which should spring next year's harvest. Surely if those who have eloquence to stir the souls of men could

be induced to abandon party strife and to use that eloquence in the cause of enlightenment, the most short-sighted of the masses might be brought to recognise self-interest for next year as not unworthy of some measure of regard.

12.—A LAYMAN'S CRITICISM OF CURRENT THEORIES OF POPULATION.

By S. CLEMES.

[*Abstract.*]

THE Population question is the root matter in all economic reasoning. But unfortunately we have not yet any universally accepted first principles in this science as we have in Physics. Malthus deserves all honor as being the first to attempt a scientific statement of the question, but we must not ignore the many sides of it which Malthus overlooked. Later investigators, such as Darwin and Spencer, must be listened to also. It has been treated too much as a mere question of figures, whereas Physiology and other sciences have also to be dealt with. Stated broadly, Malthus contends that means of subsistence only advance in arithmetical, while population tends to increase in geometrical progression. Most people accept this as proven, and even Darwin only adds, "there must of course be some natural check." Some direful prophecies quoted as to the inevitable deadlock if the present rate of increase in Australia were maintained. These calculations are only true on the assumption that we may reckon as in compound interest on money. If we really have a natural law here we ought to be able to work backwards. This would only give us, at the most, two or three thousand years for the existence of man on the earth. Geologists and evolutionists would want 50,000 or 60,000 years at least. Reliable history, of course, also shows that the obvious facts of the case are not met on this accepted theory. This mode of reckoning only admissible if each individual lived thousands of years, and each baby at once commenced to produce its kind. Census returns are generally lower than estimated population, showing that our estimates are at fault; the error less noticeable in short periods. This mode of reasoning would demand a sevenfold increase per century; no such thing demonstrable for such a length of time. Quite impossible to name a geometrical rate that could

have been maintained for any number of thousands of years. This geometrical rate would involve a constant increase of birth-rate, which Spencer has shown to be directly the contrary of the fact. The two great checks are the time needed to arrive at maturity and the cessation of reproduction. Thus from 25 to 50 may be taken as roughly the period of reproduction for our part of the human family. The elephant is the only animal approaching man in the slowness of natural increase. The birth-rate should not be reckoned on total population, but on the population of reproductive age. Sex and age should both be taken count of in our calculations. The additions due to excess of births over deaths should only be capitalised maturity. To do this periods of 50 years are necessary to get the average of 25. This would give us, at present rate in Australia, a doubled population every 50 years, which is about the fact claimed by statistics. But even this could not be maintained for very long. A better mode still would be to compare those of the reproductive ages at short periods, say of 5 or 10 years, and we should then know what the near future would probably have in store for us. But in any case only the near future can be foreseen. The birth-rate is very fluctuating, and this is a much more important factor than the death-rate. There is nothing really to be alarmed at since the present rate of increase in Australia is due to many causes exceptionally favourable to increase of population. These will be gradually changed again and the rate will infallibly be lowered. The population of the world has been probably often as numerous as at present, and in fact has always been a variable quantity and constantly changing its location. Still in any case Malthus's moral checks should be urged on all who will listen to them.

13.—AUSTRALIAN CURRENCIES.

By A. F. BASSET HULL.

[*Abstract.*]

The present paper purports to be an historical sketch of the circumstances attending the adoption and issue of the various local currencies which have, from time to time, enjoyed a more or less ephemeral existence in the Australian Colonies.

During the twelve years that followed the first settlement of Port Jackson by Captain Arthur Phillip, in 1788, up to

the first year of the present century, the "circulating medium" consisted of coins of any and every country the vessels of which traded with or called at Port Jackson.

It must be borne in mind that at this date British silver currency was very scanty in amount and of decreased value from excessive wear and tear, and filing, which all the precautions taken in the reign of George II. had not effectually prevented. A comparatively small issue of £55,459 in shillings and sixpences had been made in England in 1787, but a very small proportion of this issue made its way to the new colony, and the colonists were compelled to accept as currency those coins which were available for the purpose. Copper coin was particularly scarce at this time.

Governor Philip Gidley King arrived at Sydney in September, 1800, and very shortly afterwards published a proclamation in the following terms:—

"*November* 19*th*, 1800.

"WHEREAS representation of the want of small money experienced here has induced His Majesty to take into gracious consideration the immediate relief from this great inconvenience to all classes of his subjects in this colony, a quantity of copper coin has been received in His Majesty's armed vessel *Porpoise*, and will be circulated by being paid for grain and animal food supplied by His Majesty's store.

"These are therefore to give notice, that a copper coin weighing one English ounce, and stamped with the profile of His Majesty on one side and of Britannia on the other, will be issued as above, at the rate of two-pence for each copper, and that the same shall pass current in the colony, and is to circulate at the aforesaid rate of two-pence.

"And that no one may plead ignorance of the rate or legality of this or any other of the coins circulating in this colony, of which it does not appear that any regular proclamation has ever collectively been issued, I have judged it most expedient herewith to publish the following table of all the specie legally circulating in this colony, with the rates affixed to each at which they shall be considered and be a legal tender in all payments or transactions in this colony:—

"TABLE OF SPECIE.

	£	s.	d.
A guinea	1	2	0
A johanna	4	0	0
An half ditto	2	0	0
A ducat	0	9	6

	£	s.	d.
A gold mohur	1	17	6
A pagoda	0	8	0
A Spanish dollar	0	5	0
A rupee	0	2	6
A Dutch guelder	0	2	0
An English shilling	0	1	1
A copper coin of one ounce	0	0	2"

From this proclamation it will be seen that Governor King increased the currency value of the penny by 100 per cent.; and at the same time added a premium here and there to most of the other coins. These were a mixed lot to be proclaimed as legal tender in a British Colony.

The English penny, shilling, and guinea; the Portuguese johanna or "joe," and its half; the Indian mohur and rupee; the Chinese pagoda; the Spanish dollar; and the Dutch guelder.

At the date of the foregoing proclamation a notice was published stating that when a sufficiency of copper coin was received, of which due notice would be given, no private notes or cards would be allowed to circulate; that copper coin would not be a legal tender for any sum exceeding £5; and that the importation or exportation of copper coin exceeding £5 in value should be punished by fine of treble its value, and forfeiture of the sum so exported or imported.

At this date the smaller copper coins of half-ounce (half-penny), and quarter-ounce (farthing) were current at double their *nominal value.*

The reference to "private notes or cards" in the foregoing notice points to the probable commencement of that system of issuing promissory notes for small sums which, at first a great convenience, became subsequently the cause of such a terrible depreciation of currency.

Notwithstanding the threatened prohibition contained in the foregoing proclamation, the system continued in force and grew in importance with the growth of the colonies. Every trader regularly issued his notes, which were generally type-printed and in the following form :—

"*Sydney, May 20th*, 1810.

No. 784.

On Demand, I promise to pay the Bearer

Sixpence

In copper coin.

JOHN SMITH."

Later on the sterling money was expressed in "Spanish dollars at 5*s.* each."

Some notes were merely written, and others again—those issued by the larger business firms—were printed from copper plates in red ink, and were very creditable specimens of the engraver's art, the size of the note being somewhat similar to the bank notes of to-day.

Not only traders, but colonists generally, issued these currency notes; and from being a means of alleviating the inconvenience felt from the absence of a sufficiency of sterling money, their lavish issue finally became the cause of enlarging the difference between sterling and currency to such an alarming extent, that as early as January, 1813, the difference amounted on one occasion to 75 per cent.

The *Sydney Gazette* of 27th January, 1813 states:—"The scarcity in sterling money becomes every day more obvious, and its consequent rise in price reduces the currency to little more than one-half its nominal value. From the warehouses the generality of traders are supplied, the major part on credit; and *they* have their customers, whom *they* are obliged to credit likewise. The purchaser from the importer is required to make his payments all in sterling, and mostly sells for sterling money to the dealers, who, upon the contrary, are obliged to sell for currency, which must be converted into sterling before they can supply themselves afresh. Upon this numerous class must therefore fall the weight of the inconvenience. A difference of *fifteen shillings in the pound* has been the present week demanded, and no article laid in at the market price of the day can afford the difference; and the issuers of currency bills will find their safety and advantage in giving out no more."

Although the actual scarcity of sterling money doubtless had the effect of depreciating the value of paper currency, there were other causes for such depreciation. As I before remarked, *everybody* issued his notes as a matter of course, and the ease with which a note could be placed in circulation induced many unstable persons to float their paper, which, of course, was dishonoured on presentation. The risk involved by their presentation, therefore, was often the cause of doubtful notes being kept afloat, and becoming more and more depreciated in value.

Again, the blank printed forms being readily obtainable at the *Gazette* or other printing establishments, there was nothing easier than for rogues to purchase a quantity of

forms, number and date them, copy the signature of some reputable merchant, and place them in circulation. Perhaps it would be many months before they were presented to the supposed issuer for cash payment, and by that time they would have passed through so many hands that any attempt to trace their origin would have proved futile.

To the issuers of such notes the system was doubtless of immense benefit, so long as the currency remained anywhere near the sterling rates, for great numbers were destroyed by intoxicated persons, lost, or worn out.

When the local silver currency, to be hereafter described, was issued, notes for any less sum than two shillings and sixpence were made illegal. Although this regulation was made in 1813, when Tasmania was still a dependency of New South Wales, it did not in fact extend to this colony, as I have many notes dated about 1823, from *3d.* to 1*s.* in value.

The sterling denomination was variously expressed to be copper coin, Spanish dollars, rupees, or pounds.

After twenty-six years of use and abuse, the system of issuing promissory notes for small sums was rendered illegal by the Act 7 George IV. No. 3, 22nd September, 1826, which Act has only recently been repealed in Tasmania, at least.

During the first 40 years of existence of these colonies the Spanish dollar was the standard coin. This coin was also in general circulation in England in the early years of the present century, a large quantity having been struck to order of the Bank of England, which was paying and receiving them at the rate of five shillings and sixpence each.

In 1812 H. M. S. *Samarang* arrived at Sydney from India with a large quantity of dollars, and on the 3rd of July, 1813, a Proclamation was published in the *Sydney Gazette* stating that it had been thought proper by His Excellency Lachlan Macquarie to direct that a small circular piece of silver should be struck out of the centre of every such dollar on one side of which was the figure of a crown and the date "1813" beneath, and on the reverse side the words "Fifteen pence," and that this piece should pass current as and be a legal tender for the sum of fifteen pence sterling. That the remaining part of every such dollar, on the upper part of one side of which was impressed at its inner rim the words "Five Shillings," and at the lower part of the rim the figure of a branch of laurel, and on the reverse side of which, also around the inner rim, was impressed the words "New

South Wales" and the date "1813" should pass current as and be a legal tender for the sum of five shillings sterling. The popular names given respectively to these coins by the colonists were "Dump" and "Holy Dollar."

At this date the sterling value of the Spanish dollar in its original state was *5s.* the punching process thus raised its sterling value by 25 per cent.

The proclamation also contained very stringent regulations against forging, imitating, or uttering fraudulent imitations of either of these coins, and prohibited their exportation from the colony.

There are several die varieties of both coins in existence, but whether some of these are imitations made from good dollars by persons who wished to appropriate the extra 25 per cent. to their own use, or not, I am unable to say.

In August and November, 1822, Governor Brisbane gave notice that after six weeks the Holy Dollar and Dump would respectively be reduced to the sterling value of three-fourths and one-fourth of the Spanish dollar.

From that date until September, 1842, the currency consisted of all the coins before mentioned, together with dollars of the United States, Mexico, and various South American States, French five franc pieces, and other miscellaneous coins. From the 1st October, 1842, foreign coin ceased by statute to have any status as a legal tender in the colonies. I must go back to 1823 to describe a silver shilling token which was issued in Tasmania by Messrs. M'Intosh and Degraves, sawmill proprietors. Little appears to be known about the circumstances attending the issue of this coin, which is excessively rare. It was probably only a pattern, or at most issued for a limited period, for no contemporary reference to it can be found in the local newspapers. It is perhaps worthy of remark that the reverse is impressed with the figure of a kangaroo surmounted by the name "Tasmania." This is the more remarkable from the fact that the name of the colony was not officially changed from "Van Diemen's Land" until 1855, 32 years afterwards.

The discovery of gold in Victoria, and the consequent influx of large quantities of gold dust into South Australia, forced upon the government of that colony the necessity of making some provision for giving that gold a convertible value. An influentially signed memorial was presented to the Government by the merchants of Adelaide in January, 1852, and in consequence thereof the Bullion Act (No. 1 of

1852) was passed, authorising the "Assaying of uncoined gold, and to make bank notes, under certain conditions, a legal tender." This act was to remain in operation for 12 months only, and authorised the preparation of dies for coining gold pieces of the value of 10*s*., £1, £2, and £5. Dies were cut for £1 and £5 pieces, illustrations of which appear in the collection exhibited, but the £1 piece only was actually circulated. After a limited number had been struck, a flaw was discovered in the reverse, which was re-cut in a different type. 24,648 of the £1 pieces were issued. Three pattern pieces from the £5 die were struck, but were not put into circulation. No dies were cut for the 10*s*. or £2 pieces.

The £1 piece weighs 12½ grains more than the English sovereign, and is of equal fineness. Being worth £1 1*s*. 11*d*. it was largely bought up by English speculators, and specimens are now rare.

An interesting gold ingot is known, which is oblong in shape, about 1¾ inch by 1 inch in size, stamped in the upper half with a circle containing the inscription "weight of ingot 0 oz. 5 dwt. 15 gr. Equivalent weight of 22 carats 0 oz. 9 dwt. 11 gr." and below "(crown) S.A. 23 carats." It is stated that this ingot was stamped at the assay office pending the issue of the authorised pieces. Two copies are known to exist.

Four gold pieces are in the British Museum, the obverse of which contain the figure of a kangaroo, with date 1853 beneath, and surrounded with the inscription "Port Phillip, Australia," the reverse contains the figures 2, 1, ½, and ¼, respectively, surrounded with inscription "Pure Australian Gold." "Two (one), (one-half), (one-quarter) ounces." These are believed to be patterns only.

About 1850 a sudden impetus was given to trade by the gold discoveries, and a marked want of copper coin began to make itself felt. At the time the chief copper coins current were the large penny and halfpenny of Queen Victoria, coined shortly after her accession; next to which in order of frequency came the penny and halfpenny of George IV., and, in a less degree of frequency, the coins of George III. and William IV.

Notwithstanding the large variety in circulation, the quantity was quite inadequate to meet the requirements of the rapidly increasing trade. The immediate result was the issue of a large number of tradesmen's tokens throughout the colonies.

So long as these tokens were issued *bonâ fide* to assist the copper currency they were of immense benefit to the colonies generally, but when some less conscientious tradespeople began to make a business of the issue of their tokens with a view to obtaining the use of the money represented by the number in circulation, and when others repudiated theirs, the benefits of the system became gradually less apparent. The "Bronze Moneys Act" of 1875 rendered the issue of tokens illegal in Tasmania, and about the same period similar Acts were passed in the colonies of the Continent, but New Zealand continued to use them until quite a recent date.

I have compiled a list of 452 varieties known at present, distributed as follows:—Victoria, 189; New South Wales, 74; New Zealand, 92; Tasmania, 48; Queensland, 22; South Australia, 13; Western Australia, 6; and miscellaneous, 8. There are doubtless more varieties to be described which I have not yet met with.

Between 1854 and 1858 Messrs. Hogarth and Erichsen, jewellers, Sydney, issued eight varieties of silver threepenny tokens, the metal of which is very much alloyed.

A threepenny token, composed of pure silver, was issued in Sydney in 1854, probably by some private firm, but it only bears the inscription of "Silver token—Sydney, New South Wales, 1854." It is rather uncommon.

The last series to be noticed comprises the well-known sovereigns and half-sovereigns coined at the branches of the Royal Mint in Sydney and Melbourne.

The Sydney branch commenced coining in 1855, and the design of the first issued consisted of—Obverse, head of Queen Victoria to left, with two plain bands round the head, with date 1855 beneath. Reverse, two olive branches forming a wreath tied together with a ribbon, "Australia" surmounted by a crown in the centre; "Sydney Mint" above the wreath, "one" or "half-sovereign" beneath.

A new type was substituted in 1857, the head being adorned with a laurel wreath, and this type for both sovereigns and half-sovereigns continued to be issued until 1871.

In the latter year a second branch of the Royal Mint commenced operations in Melbourne, and the types of the British counterparts were coined at both branches; a minute mark, S. for Sydney, and M. for Melbourne, only distinguishing the Australian gold from that coined at the Royal Mint.

The total value of gold coined by the Sydney Mint from 1855 to 1870 amounted to upwards of £27,000,000.

The immense value of the two Australian branch Mints may be easily seen from the fact that during the year 1881 the British Mint struck no gold coins whatever, whilst the local branches raised no less a sum than £3,736,800.

14.—NOTES ON THE VALUE OF LABOR IN RELATION TO THE PRODUCTION OF WEALTH: REGARDED FROM THE STANDPOINT OF A PHYSICIST.

By ALFRED J. TAYLOR, F.L.S., F.R.G.S.E.

[*Abstract.*]

It may be well, at the outset, if I define the senses in which the terms *wealth* and *labor* will be used in this paper. The term wealth will be used to mean that which is profitable to man in satisfying his desires. In using the term labor, while not excluding mental effort, I shall refer principally to what is popularly spoken of as the labor of the hands (the class of effort put forth by those who are said to earn their living by the sweat of their brow).

The difference in the relative value of the two classes of wealth that satisfy human desire is very great, and it needs no argument to demonstrate the fact that the wealth that is necessary to the sustenance of life must be of infinitely larger importance than the wealth that merely affords satisfaction on contemplation—or in the idea of possession. Wealth, in the shape of food, for example, would be of far more value to a man on a raft in mid-ocean than the possession of kegs filled with diamonds or gems of literature and art.

Wealth, essential to the sustenance of life, may be broadly classed under the term Necessaries: the other form of wealth referred to, under the term Luxuries.

What produces wealth?

It has been truly said that "No theory of labor or work, no philosophy of the production of those things which sustain and gratify human life, can rest upon any accurate and scientific basis unless it be founded upon the clear and accurate comprehension of certain fundamental physical truths."

The fundamental physical truths referred to are these:—
1. That the only real things in the physical universe are matter and energy. 2. That matter is indestructible and invariable in quantity. 3. That matter cannot be transmuted

from one kind to another. 4. That the sum total of energy being always constant, no portion of energy can be put out of existence or created by any power at the command of man. 5. That energy may be readily transformed—although the quantity present will remain the same. 6. That all the physical changes that take place, including those that are inseparable from thought, are merely transformations of energy. 7. That energy may be—1. Potential (in position); 2. Kinetic (or in motion).

Now, the Universe is a vast storehouse of energy, and the great problem set for human ingenuity to solve is how to transmute energy so that it may become most useful and serviceable to man.

It is to this great storehouse of energy that we must look for the real source of wealth.

All labor implies the pre-existence of capital that can be drawn upon to satisfy every desire of human life, and this capital is only to be found in the vast stores of energy in Nature that are ever ready for transmutation and adaptation to the requirements of man.

If so much has been admitted, the following conclusions will also be accepted:—1. That the only way in which labor can aid in the production of wealth is by taking advantage of the natural energies that surround us; 2. That all labor means a consumption of energy; 3. That labour may be *un*productive.

That labor may be unproductive needs little argument to prove; and yet, strange to say, we continue to find some economists who do not hesitate to assert that labor is the only source of wealth, and men like Henry George declaring that "Nature gives wealth to labor, and nothing but labor," and supporting their contention by illustrations that clearly indicate the little attention they have given to an understanding of those fundamental physical truths essential to a proper and scientific view of the question they profess to grapple with.

"The value and magnitude of the produce," says Philip, very correctly, I think, "depends not on the productive power of labor, but on the definite and measurable quantities of the potential energy of Nature which the product contains, and which are in no sense created or called into existence by anything that man can do."

Labor must be thought in action to be profitable to man; for the admission that labor may be unproductive is an

admission that the mere exertion of labor is not essentially a productive process. A larger amount of labor may be expended in cultivating a poor piece of land than in tilling a rich piece of soil; but the results in wealth will not be proportionate to the labor expended, but to the favorable conditions under which the labor is applied.

What position, then, does labor really occupy in relation to the production of wealth?

I have already pointed out that, to be profitable to mankind, labor must be thought in action; and the truth yet remains to be fully realised that physical exertion, to be profitable, need not necessarily be any more thought in action than the working of a steam-engine or the beat of paddle-wheels overcoming the resistance of opposing waters.

And this brings me to the all-important point of my paper, that back of muscular effort (which in itself is merely an expenditure and consumption of the potentialities of fuel supplied in the form of food), *intelligence*, which can alone grasp the meaning of Nature's riddles, must map out the one course to be taken if the end aimed at is to be attained.

Labor, then, must be conducted intelligently, and not at haphazard, if the forces of Nature are to be turned to profitable account. *Thought* must work out the problem, and muscular effort, by depositing certain materials in one place rather than in another, may become a factor in the augumentation of the potential energy that it is the object and intention of thought to conserve for the sustenance of life and the purposes of civilisation.

To this extent, and only so far, may labor (the class of labor I have referred to as the labor of the hands) lay claim to a share in the production of wealth.

The problem of the future is how to render large supplies of potential energy available for the sustenance of life and the progress of the human race.

This problem cannot be solved by endeavours to persuade the ignorant and credulous that by the exertion and application of mere brute force they are the creators of wealth, and that they above all others possess the creative power that belongs alone to the all-sustaining influence of which all forms of energy are but the expression and manifestation.

15.—THE OBLIGATIONS OF A CIVIL GOVERNMENT.

By HON. J. W. COTTON, M.L.C.

16.—THE WEALTH OF AUSTRALASIA.

By T. COGHLAN.

Section G.

ANTHROPOLOGY.

PRESIDENT OF THE SECTION:
REV. LORIMER FISON, M.A.

1.—THE STORY OF TU AND REI; A MANIHIKIAN MYTH.

By THE REV. WILLIAM WYATT GILL, LL.D.

Introduction.

Almost in the centre of the South Pacific, about 700 miles N.N.W. of Rarotonga, lie the twin atolls of Manihiki and Rakahanga. These islands, twenty-five miles apart, are inhabited by one race descended from a single pair, Toa and Tapairu, natives of Rarotonga.

The following interesting myth was communicated to me by Ioane, a native minister of Manihiki. Ioane derived it from his aged father, one of the recognised repositories of ancient wisdom, who was past middle age when Christianity was introduced to those atolls in 1849.

The original text of the native is subjoined—the only specimen of the Manihikian dialect ever printed. A few Rarotongan words have however crept in, owing doubtless to Ioane's perfect acquaintance with the language of the political capital of the Hervey Group.

Two years and a half ago these atolls were, at the earnest request of the natives, annexed to Great Britain.

The food of these islanders consists merely of fish, coconuts, and a coarse kind of *Caladium* (called by the natives "puraka") grown on Rakahanga. Annual voyages are made by the natives of Manihiki to the sister island in canoes, for the purpose of obtaining a supply of "puraka"; in these expeditions many lives are lost through sudden storms. The voyage should be accomplished between sunrise and sunset.

Myth.

In spirit-land, in the district[1] of Kurakau, lived Tu and his

[1] In Polynesian mythology Spirit-world is mapped out into districts, under the rule of chiefs, as the islands themselves are.

wife Rei. Now Rei conceived, and in due time gave birth to a daughter called Ina. A long while afterwards Rei again conceived. The husband, judging from her appearance, concluded that there would be twins, and said to his wife, "If my expectations prove correct, we will name the first-born Taramaakiaki, the second Taramahetonga."

One day they determined to go to the ocean to dive for clams. Accordingly they launched their canoe and paddled to a distance where they knew clams to be abundant. Now a female demon, Tuherepunga, whose home was at the bottom of the ocean, caught sight of Rei, who was indeed a woman surpassingly beautiful to look upon. The demon coveted the lovely form of Rei and resolved that it should become hers.

Utterly ignorant of the plottings of this foe, Tu and his wife arrived right over the vast bed of clams, and Rei[1] at once dived down to the coral bottom amongst them. While the wife was thus busy, the envious demon rose up out of the ocean in human form, exactly like Rei in face, locks, and even the size of her abdomen. Tu gazed on the woman and concluded that it was his wife. The demon said to Tu, "Let us paddle a little farther on." Forthwith she got into the canoe and away they paddled, Tu all the while believing her to be his wife. But they had not paddled far, say a dozen fathoms,[2] when Rei came up from the bottom bearing with her some clams. To her surprise she found that Tu and the canoe were gone. On looking again, she saw her husband with a woman in the canoe paddling away from her. She at once shouted out, "Oh, Tu, 'tis a stranger woman that you have in the canoe. Here am I, even Rei."

At this the female demon said to Tu, "Do not gaze upon her, for she is the evil spirit, Tuherepunga, calling to us. Fix your eyes on *me*, for I am Rei and there are twins in my womb." Thus was Tu deceived and led to forsake his true wife. Tu, assisted by the female demon, now paddled back to shore.

In her distress Rei prayed[3] [to her god] for a great billow

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[1] Only one could dive; the other must remain in the canoe to prevent it from capsizing or drifting away. *Rei* is appropriately represented as diving, clam-diving being now, as from time immemorial, women's work on those atolls.

[2] Polynesians always measure by the fathom, *i.e.* both arms of a tall man outstretched.

[3] Rei being *enciente*, felt that she could not swim to land after the exhaustion of diving. The only resource left was to invoke the aid of her god.

to carry her ashore. An immense wave rose round her. Still her incantation proceeded that it might rise higher yet. Even so it came to pass; the vast volume of water curled up and carried her ashore to the sandy beach. And now the pangs of child-birth commenced; after awhile twins were born.[1] [In accordance with her husband's wish] she named the first Taramaakiaki, and the second Taramahetonga. The place where the twins were born was a wild uninhabited spot, far from the dwelling of her husband.

Rei carefully tended her twin children until they became able to take care of themselves. The place where they lived abounded in coco-nut palms, and the sandy soil was covered with fallen nuts. It was on the rich kernel (scraped fine) and soft pith of these nuts that the children were nourished. Fish of all kinds could easily be obtained.

One day the twins, now grown up into big lads, asked the name of their father. Rei answered, "Yon post[2] of the house [you see] standing is your father, and I am your mother." Another day they repeated the question, but Rei would not satisfy their curiosity. At length she asked the boys, "Do you really want to know your father?" "We do indeed," was the reply. The mother therefore taught them the house-incantation.[3] In a short time they got it off by heart. Rei made them chant it; but found that whereas the elder lad dropped out a word here and there, the younger one recited it with absolute correctness.

Rei then told the boys to go in search of her brother. "Tell him my wish that he fell[4] a tree [to make] a canoe for you my children; but the tree to be felled must be one growing in a wild[5] spot. The boys started off and carried out their mother's instructions. The maternal uncle assented and pointed out a suitable tree. The twins now scraped the kernel of some coco-nuts, enough to fill two baskets. This done, the elder lad called to the great land crabs (= tupa),

[1] Native women on those low-lying atolls know exactly what to do for themselves under such circumstances. When the husband is at hand, it is *his* duty to perform the office of accoucheur.

[2] This is the native way of evading an awkward question.

[3] A house-incantation is one that is used on entering your own dwelling, lest any mishap occur. It is, of course, a family secret.

[4] The uncle (to the native mind) felled the tree, because (1) he pointed out a suitable tree growing on his land, (2) the scraped coco-nut was his property, (3) the crab carpenters belonged to the estate. No land in those atolls is unclaimed. Timber fit for canoe building is especially valuable. Compare the legend of "Rata's Canoe," "Myths and Songs," page 144.

[5] Evidently to correspond with the wild place where the twins had been born and brought up. The scene is still laid in Spirit-land.

the tiny land crabs (= karaii), and the medium-sized land crabs (=kākara)—in fact to crabs of all sorts and sizes that crawl over the sandy soil—to come and fell the tree for their canoe. So the crabs came, but not in sufficient numbers. Observing this, the younger brother called to the crabs, even as the elder brother had done. Vast multitudes now came at the voice of the younger boy. The crabs [with their claws] felled the tree, dug out the canoe, and finished it off. In a single night the canoe was made and dragged to the sea. When the task was finished the crabs came back [from the sea] to feast[1] upon the delicious morsels prepared for them [by the boys].

At daylight the twins paddled back to their mother, who now desired them to go to the most distant part of the atoll. If they saw on the sea abundance of drift-wood and rubbish, it was not the right place. But if they came to a white sandy beach—all glittering in the sun—it would be their destination, the home of their father Tu, and of their sister Ina, and of Tuherepunga.

So the boys paddled on until they arrived at the place indicated, and then landed. On coming to a spot near the sea where fishbones and other refuse were thrown, they hid their canoe by sinking it. Advancing now a little way, they perceived a man, a girl, and a woman very like [their mother] Rei. The man and the girl were in one hut, the woman in another [close by] engaged in mat weaving.[2] But the lads were unseen by all three.

The twins now changed their shape. They transformed themselves into robber-crabs and crawled to the side of the hut occupied by the woman, making the usual noise of those crustaceans. The man called out to the woman, "What is the noise outside?" The woman replied, "Don't you perceive[3] that it is only the crabs—of all sorts and sizes—of this our island?"

After awhile the noise was again heard, and the woman rose and went outside to see. She found it was made by a couple of fine robber-crabs. The delighted woman called out, "What a treat[4] I have got!" At this she secured them

[1] Payment for work was usually made in food. The work must be done ere the hungry carpenters taste the feast.

[2] Mat-weaving was practised on Manihiki and Rakahanga from time immemorial. Yet on some volcanic islands (notably Mangaia) this useful art was unknown.

[3] A native answers a question by putting another. This habit is universal.

[4] A great delicacy in the estimation of the islanders.

with strong sennit-cord, and pulling them into the larger dwelling, tied them to the principal posts. Husband and wife then proceeded to heat the oven in order to bake the two great robber-crabs. Now the crabs were made fast to separate posts [to prevent their escape.] The daughter [Ina] came and sat down near the captive robber-crabs, who now plaintively spake thus with human voice :—

"Oh! Ina, we have the same father, even Tu; and the same mother, even Rei." At this the girl ran to tell Tu, who replied, "Don't go[1] near them, lest you be tempted to release them, and so they escape." Ina, however, came back, and the robber-crabs again plaintively uttered the same words. The girl again ran to her father and told him what they said. Tu desired her to ask their names. Ina did so, and the robber-crabs informed her that Taramaakiaki was the name of the elder, and Taramahetonga the name of the younger. As soon as Tu was told this, he grasped the situation, for he now recollected the covenant he had [long ago] made with his wife as to the names of the twins when they should be born. He reflected, too, that the woman whom he and his daughter called Rei had been seemingly pregnant for six or seven years without giving birth to a child!

Tu ran into the hut, but the lads now resumed their human form. He demanded of them whether they knew the the house-incantation. They replied, "Yes." Tu immediately put their knowledge to the test. The elder lad went through it, dropping out, however, as Tu noted, a word here and there. The younger lad then went through it, and Tu knew that it was absolutely correct. It was in this way that Tu became convinced that these lads were his own children.

Tu now asked the demon wife whether *she* knew the house-incantation. "A little bit of it has slipped from my memory," she replied. The husband said, "[2]Chant it then." She accordingly chanted these words :—

> In the far-away deep sports the great white shark;
> But in the near sea moves the common blue shark.
> Catch! Slay!!

At this Tu gripped the hands of the demon wife—inasmuch as this was *not* the house-incantation—and threw her on the

[1] Tu was sceptical about the statement of these wonderful crabs; but that the crabs should speak did not surprise him at all.

[2] The demon-wife utters an incantation which smacks of her original form and true home in ocean depths. She is made to tell the man she so cruelly wronged to "catch" and "kill" the denizen of the deep, which he does with great zest.

oven which they had just been been heating for the children. In a short time the abdomen of the demon-wife burst with the heat, and lo! a great lump of lime-making coral fell out. As soon as the twins were sure of the death of the demon-wife, they ran to their canoe and paddled back to their mother[1]; Tu and the sister following in another canoe. When Tu arrived at the place where Rei was, he wept over his wife and the twin sons. Rei too wept over her husband and daughter. Finally they all returned to their ancient home in peace and prosperity.

Song of Ina and her Brothers.

1.—Marama hiti ake te tauaruea.
Ko hiti mai a tia oa!
Hiti ake!
Hiti ake i tua o Matavera te tauaruea,
Ko hiti mai a tia oa!
Ka hakune!
Ka hakune! Ka hapopo!
Ta kainga ta mahu a hapa e!
Te tauaruea.

Hail glimmering light of the rising moon!
Shine forth in thy full glory!
Shine forth!
Shine forth from behind Matavera, thou lovely one!
Shine forth in thy full glory!
(In thy presence we partake of) our stale food;—
Stale food;—food covered with mildew;—
Scraped "puraka"—all bad.
Hail lovely (moon-goddess)!

2.—Koai e ana tama i ana mua e, te tauaruea?
Ko hiti mai a tia oa!
Na! Ko Ina!
Ko Ina rangai vaka,
Te tama a Rei vaka, te tauaruea.
Koai e ana peke i ana tua e, te tauaruea?
Ko hiti mai a tia oa!
Ko Tarama,
Ko Taramaakiaki, te tama a Rei vaka, te tauaruea?
Koai e ana peke i ana muri e, te tauaruea?
Ko hiti mai a tia oa!
Ko Tarama,

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[1] Evidently Tuherepunga, with her craft and strength, was well-known to Rei; hence she did not seek out her husband until her boys were grown, or she would have been no match for her foe.

There is a play upon the word "punga," which in those islets means "a lump of lime-making coral." Accordingly the demon's name is "Tuhere-*punga*," *i.e.* "Tu-who-carries-about-lime-coral," or "Tu-*enciente* with coral."

Ko Taramahetonga, te tama a Rei vaka, te tauaruea.
Ko hiti mai a tia oa?
    Ka hakune!
Ka hakune! Ka hapopo!
Ta kainga ta mahu a hapa e!
  Te tauaruea!

Where is the first-born of his children, thou lovely one?
  Shine forth in thy full glory!
  Yonder is Ina,—
  Ina the pride of the land,
  Daughter of Rei, the renowned.
Where is the next-born of his children, thou lovely one?
  Shine forth in thy full glory!
  Here is Tarama,—
Even Taramaakiaki son of Rei, the renowned.
Where is the next-born of his children, thou lovely one?
  Shine forth in thy full glory!
  Here is Tarama,—
Even Taramahetonga, son of Rei, the renowned.
  Shine forth in thy full glory!
  (In thy presence we partake of) our stale food;—
  Stale food;—food covered with mildew:—
  Scraped "puraka"—all bad.
  Hail lovely (moon-goddess)!

The worship of the moon-goddess is intermixed with farcical allusions to the very indifferent diet of her worshippers. This is eminently characteristic of Polynesian idolatrous cult.

"Matavera" is the name of the most distant district of spirit-land. *There* may be seen the aperture through which the lovely moon-goddess climbs up at night.

This song is unique.

Ko te tua teia ia Tu raua ko Rei; e tua no Manihiki.

Ko Tu te tane, ko Rei te vaine, ko Kurakau te enua (tei Avaiki). Kua nui a Rei, kua anau, e tamaine, ko Ina te ingoa. E roa akera, kua nui akaou a Rei, kua akara te tane i te vaine, kua tuke te kopu o te vaine, tera ta raua tuatua, e maanga paa tei roto i te kopu. Me anau mai e, e maanga, tera nga ingoa, ko Taramaakiaki tetai, ko Taramahetonga tetai. E tae akera ki tetai rā, kua inangaro raua ka aere ki taatai, ka ruku pāua. Aere atura raua na runga i to raua vaka, e tae atura ki te ngai e ruku ei i te pāua, tera tetai vaerua kino tei raro i te moana, te akara ua ra kia Rei, no te mea e vaine purotu a Rei i te akaraanga.

Ko Tuherepunga te ingoa o taua vaerua kino ra. Kua noinoi taua vaerua kino ra i te tutu o Rei, kia riro ei tu nona. Kua tae raua ki taua ngai ruku anga pāua ra, kua ruku iora a Rei ki raro i te moana. Kua ea mai taua vaerua kino ra ki runga. Kua tu a tangata te tu, mei te tu tikai o Rei tona tu, te mata, te rauru, e te maata i te kopu. Kua akara a Tu ki te vaine, ko tana vaine ïa. Te karanga ra te vaine kia Tu, o atu ka oe taua. Kua kake ki runga i te vaka, kua oe atura raua. Kua vare a Tu e, ko tana vaine ïa. Kare raua i mamao ke atu, ka tau ki te okotai ngauru ma rua etateta te roa, kua ea mai a Rei mei raro i te moana ma nga pāua, e kia akara aia, kare ua a Tu e te vaka atu : E kia akara atu aia, kua oe ma te vaine katoa i runga i te vaka. Kua kapiki atura aia, E Tu e! e vaine ke te vaine i akauta atu ei koe na. Teia au ko Rei!

Te karanga ra tua vaine ra ki te tane, Auā e akara atu, ko Tuherepunga tera e kapiki maira kia taua. Akara mai koe iaku, teia rai ko Rei, akara koe i te maanga i roto i taku kopu. Te vare ra a Tu, akaruke atura i tana vaine tikai. Oe atura raua ki te enua.

Kua tautopa iora a Rei ki tetai ngaru tai, ei kave iaia ki uta i te enua, kua akaututuaia maira tetai ngaru, kua kapiki aia kia teitei, e kua teitei ua atura taua ngaru ra, e kua aatu ki runga iaia. Riro atura aia, na te ngaru e taoi ki uta. Tei tona tae anga atu ki uta, kua mamae anau iora aia, e roa akera kua anau aia, e puke tamariki tokorua, e maanga raua. Te tapa ra aia i nga ingoa, ko Taramaakiaki tetai, ko Taramahetonga tetai. E ngai motutaa ua teia ngai, e mamao te ngai i noo ei te tane.

Kua ikiiki iora aia i ana puke tamariki tokorua e mamaata raua. Kua inangaro nga tamariki kia kite i to raua metua tane. Te ui ra ki te metua vaine, Koai to maua metua tane? Kua karanga a Rei, Ko te pou e tu mai na to korua metua tane. (E pou are nei taua pou ra.) Ko au to korua metua vaine. Kia tae ki tetai rā, kua ui akaou, kare rai a Rei i akakite. I reira a Rei i karanga i kia raua, Kua inangaro ainei korua kia kite i to korua metua tane? Kua karanga raua, Kua inangaro maua. Tera ta te metua vaine i apii ia raua, e pe'e no te are. Kare e roa kua mou ngakau ia raua. Kua inangaro a Rei kia tumu i te pe'e nga tamariki; e topatopa aere te pe'e i te tuakana, ko te teina kare ïa e topatopa. Te karanga ra a Rei ki nga tamariki, E aere korua e kimi i toku tungane; e akakite korua te karanga atu nei au, e tipu i tetai vaka no korua, ko te rakau i te ngai

ngangaere o te enua ko ta korua ïa e tipu. E kua aere raua kua akapera i ta te metua vaine i tuatua maira. E kua akatika te tungane, e kua akakite ki nga tamariki i te rakau. Tera ta aua nga tamariki i rave, kua varu raua i etai akari ki runga i e rua kikau. E oti, kua kapiki te tuakana kia aere mai te tupa, te karaii, te kākara, te au manu totoro ravarai mei te reira te tu, ei tipu i to raua vaka. E kua aere mai, kare ra i maata tika. E kua kapiki akaou te teina, mei ta te tuakana ra, e kua maata ua atura tei aere mai i te reo o te teina. Riro atura na ratou e tipu i te rakau, e na ratou e maani i te vaka. Okotai po, kua oti te vaka, e kua kika ki te tai. Kua oki mai aua manu kua kai i te akari. E kia popongi kua oe atura aua tamariki ra ki te metua vaine. Kua akakite te metua vaine kia raua, E oe korua na tera pae enua; me kite korua i te rakau pānu aere ma te teita, e ngai ke anake ïa. Me kite korua i tetai ngai moteteākāua, koia ïa, tei reira to korua metua tane, ko Tu te ingoa, e tei reira to korua tuaine, ko Ina, e tei reira katoa a Tuherepunga.

Kua oe atura raua, e tae atura ki taua ngai ra, kua kake ki uta. Kia tae ki te ngai tiringa teita i te pae tai, kua akatomo raua i to raua vaka ki te tai, kua aere atura raua, kua kite i tetai tangata, e te tamaine, e tetai vaine mei te mea e ko Rei tona tu. E are ke to taua tangata ra ma te tamaine; e are ke to te vaine. Tera ta te vaine angaanga, e raranga moenga. Kare ra ratou i kite mai ia raua.

I reira kua akatuke raua ia raua. Kua akatutu a ungā-onu ia raua, kua totoro mai ki te pae i te are o taua vaine ra, kua akaparaparara ki te pae are. Kua kapiki mai te tane ki taua vaine ra, Eaa teia paraparara i vao? Kua karanga te vaine, Kare koe e kite, ko te kākara ma te karaii, e te papaka i to tatou enua? E roa, kua paraparara akaou; e kua aere atura taua vaine ra ki vao, kua akara, e ina! e ungā-onu teia, e rua. Kua rekareka. Tera te tu reo kapiki, Aue! taku tauanga fakāriki! Kua tapeka ki te taura e kua kika mai ki roto i te are maata, e kua tapeka ki te tumu i te pou; e kua aere raua, te tane e te vaine ki te taû i te umu no aua ungā-onu ra; e kua tapekaia tetai ki tetai pou, tetai ki tetai pou. Kua aere mai te tamaine ki te pae o nga ungā-onu; kua tuatua a tangata atura nga ungā-onu kiaia, E Ina e! okotai o tatou metua tane ko Tu, okotai o tatou metua vaine ko Rei. Kua oro atura aia e kua akakite kia Tu. Kua tuatua maira a Tu, Auā koe e aere ki te pae, ka tatara aea koe, e ka oro aea. Kua oki mairā Ina kia raua, kua tuatua akaou atura i taua tuatua ra, e kua akakite akaou

atura aia kia Tu. Kua tuatua maira a Tu, E ui atu koe, koai ma o raua ingoa? Kua ui aturā Ina, e kua aaki maira kiaia, kua akakite aturā Ina kia Tu, ko Taramaakiaki tetai, ko Taramahetonga tetai. Kua mārama iora te manako o Tu, ma te akamaara ki ta raua tuatua i oti e, ko te ingoa rai ïa me anau mai. Ko te ingoa o taua vaine ra i te kapiki anga a Tu e te tamaine ko Rei, akamaara, kua tae ki te ono e te itu o te mataiti, kare akera taua vaine ra i anau. Kua oro maira a Tu ki roto i te are, e ina! kua tu a tangata raua. Kua ui atura aia kia raua, Kua kite ainei korua i te pe'e o te are? Kua tuatua atura raua, Kua kite maua, Kua timata iora a Tu kia kite aia i to raua pakari e to raua kite. Kua timata ki te tuakana. Kua pe'e aere te tuakana; e kua kite a Tu e, te topa rikiriki aere ra tetai ngai. E kua pe'e te teina; kia akarongo a Tu, kare e ngai i topa iaia. E kua maara tikai a Tu e, nana tikai eia tamariki.

Kua kapiki atura a Tu ki te vaine, Kua kite ainei koe i te pe'e o te are? Kua tuatua maira te vaine, Ko tetai taka tuatua ngaro ïa! Kua tuatua atura te tane e, Pe'e mai koe. Kua pe'e atura aia,

Tei tua ta parata,
Tei tai ta mango,
E pi! E pa!

Kua mou aturā Tu i te rima o te vaine, no te mea kare, ïa pe'e i te pe'e o te are, kua titiri atura a Tu i taua vaine ra ki runga i te umu ta raua i taû no aua tamariki ra. E kia ngaa te kopu o taua vaine ra ki runga i te umu, e ina! e punga maata tei roto i te kopu, mei te punga ngaika nei te tu.

Kia kite nga tamariki e, kua mate taua vaine ra, kūa ooro atura raua ki to raua vaka, e kua oki atura ki te metua vaine. E kua aru atura a Tu e te tamaine ia raua; e vaka ke rai to raua. E kia tae ki te ngai tei reira a Rei, kua aue iora a Tu ki te vaine, e ki nga tamariki. E kua aue katoa a Rei ki te tane, e ki te tamaine. E kua oki atura ratou ki to ratou ngai tikai ma te meitaki.

The native text for Ina's song having been already given, need not be repeated here.

2.—OMENS OF PREGNANCY, MANGAIA, HERVEY ISLANDS.

By THE REV. WILLIAM WYATT GILL, LL.D.

If a married man dreams of catching prawns, or of gathering red pandanus drupes,[1] it is a sure sign that his wife will conceive and the child will be a boy. Should the dream be of *Gardenia*[2] flowers, the expanded blossom prefigures a boy, the unexpanded a girl. Should the dream be of a bed of buried stone adzes, one very large and the rest much smaller, and that a friend is with you at the time of the discovery; then *you and your friend* will both become parents. The party who gets the big adze will have a boy, the other a girl.

My valued Polynesian friend, Mamae, had been married a year without expectation of increase, when he dreamed that he and Anui (his friend and relative) had luckily discovered a bed of stone adzes at a place called Touri, in the district of Tevaenga. Early next morning Mamae started off with his brothers to secure the treasure trove, *i.e.* the buried adzes[3], then much in request. The brothers dug for hours at the place indicated in the dream; but all in vain! Late in the afternoon they gave up their bootless search. Their old uncle Tiaea hearing what the young fellows had been doing, sent for Mamae and angrily demanded how he dared to dig the sacred soil of Tevaenga. To appease the wrath of the old heathen, Mamae told his dream. At this the uncle laughed heartily and remarked "the dream means that you and Anui are about to become parents." And so it turned out; for Anui's wife bare him Teara, his eldest son and successor in the chieftainship; Mamae's wife also bare a son who died early.

A night or two afterwards, Mamae dreamed that he was gathering red pandanus drupes. So, emphasized Mamae,

[1] These were strung together for necklaces, alternating with the bell-like blossoms of the *Hernandia*. In full dress a man or a woman might wear half a dozen of these necklaces, some doubled and others reaching the knees.

[2] The *Gardenia* blossom (the flower of flowers in native estimation) was, and still is, worn in the pierced ears of both sexes.

[3] On the eve of battle it was customary to bury the stone adzes of the family in some out-of-the-way place. Beds of these (in heathen times) priceless treasures are still occasionally discovered. About a dozen adzes, large and small, were arranged in a circle, the points being towards the centre. The knowledge of the localities where to find them was carefully handed down from one generation to another until the last of the tribe was slain. Sometimes a couple of adzes would be hidden in the cleft of a rock, well wrapt up in native cloth to elude observation.

both omens proved true! I found it impossible to shake the faith of my otherwise very intelligent native friend. I may add that Mamae, who at baptism received the name Sadaraka, was grandson of the poet Koroa, many of whose songs are given in my " Myths and Songs from the South Pacific.

3.—NEW BRITAIN AND ITS PEOPLE.

By REV. B. DANKS.

1.—*The Country.*

THE group of islands formerly known as the New Britain Archipelago, but now the Bismarck Archipelago, lie about four degrees south of the line, and consist of two large and a number of small islands. New Britain is 300 miles long, and has an average width of about 50. New Ireland is about 200 miles long, and has an average width of about 12. These two islands are separated by about 40 miles of water, called St. George's Channel. The most important of the small islands is the Duke of York Group, which lie midway between the two large islands.

New Ireland seems to be much older, geologically, than New Britain, or at least of that portion of New Britain with which we are most intimately acquainted. Chalk is found there in large blocks, out of which the natives carve images. This has not been found in New Britain so far as we know. The shores of New Ireland are strewn with waterworn boulders and stones for many miles, while brooks and rivulets are to be found every few yards. The Duke of York Group partakes largely of the geological character of New Ireland, but bears many signs of volcanic action in caves, vent-holes, and many other signs. The channel dividing the islands is deep, and frequently very stormy. Strong currents frequently run in at the rate of about five miles an hour, and it is frequently very difficult for sailing vessels to get through it.

The soil of New Britain is mostly scoria. Volcanic cones, extinct craters, and other signs proclaim New Britain to be of volcanic origin. During the 16 years of our mission history an eruption took place, a new volcano being formed, and a new island thrown up in Blanche Bay. Earthquakes are frequent, and often severe. Rivers are few and far between. The soil is so porous that the heavy tropical rain is quickly absorbed, comparatively little of it reaching the

sea as surface water. Springs are not so numerous as might be expected under the circumstances, but for miles, in fact everywhere along the coast, at low tide the water is seen bubbling up, and one has only to scrape a hole at any time close to the sea to get a supply of good fresh water.

Waterspouts are frequently seen near to the shore and far out in the channel. One gets so used to them that he can tell the kind of cloud which will eventually become a waterspout, and suddenly as he watches the rope-like connection is formed between sea and cloud, and, if near shore, the whirl and roar of the waterspout is heard.

Three large extinct volcanos, called the Mother and Daughters, are on the east coast, and three others, called the Father and Sons, are on the north east coast, and at the time of my visit to that part they were emitting smoke.

Pearl shell is found there, but not in any very large quantity. Some of it, the "black lip," is good, but not of the best kind, while the "gold lip" is of good quality, but there is but little of it. Bêche-de-mer is there, but of a poor quality. It does not pay to cure it. Cocoa-nuts are abundant, and many hundred tons are exported to Europe annually by the various trading firms. A kind of cedar grows upon New Ireland, but I believe it is not plentiful. There is an abundance of sugar-cane, but of a poor quality. It needs but the introduction of a better kind to make this an article of commerce. Coffee will grow well there. The timber is, with one or two exceptions, of a soft kind, the hard being very hard, and difficult to work.

2.—*The People.*

The inhabitants of the New Britain group are Papuans. In some respects they are of a lower type than some of the Papuan tribes of the South Seas. On the whole, however, they are industrious and intelligent—as we understand the terms when applied to savages—and when brought under tuition they display considerable aptitude in acquiring knowledge. They are of a chocolate colour, about five feet five as an average height, and with features not nearly so repulsive as the Australian black. In their habits they are not nearly so clean as they might be, to put the matter mildly.

Their hair frequently hangs in a long tangled mass about their eyes and ears. They are quite innocent of such articles as combs, and when the irritation caused by its tangled, filthy

condition cannot be endured, even by them, any longer, they simply shave it off altogether with a flake of obsidian, or glass, or a strip of bamboo as a razor. They dress the hair in various ways. A common method is to use powdered lime: not mixing it with water, as do the Fijians and other South Sea islanders, but simply the dry lime. This has certain cleansing properties, and it also changes the colour of the hair to a dirty white. They also daub a red earth mixed with a little cocoa-nut oil upon it, and this suits them better than any other method. I have seen men with one-half the head and face daubed with red paint, the other half a light green. When in mourning for the dead they use a black pigment, made by mixing the tinder of burnt grass with cocoa-nut oil, daubing it about the hair, face, and body. When this is used they look exceptionally filthy, even for them. They do not anoint the body with oil as do many South Sea islanders, and the skin being continually exposed to sun and wind becomes coarse-looking and tough. They are great believers in blood-letting for all aches and pains, so that it is difficult to find an individual whose skin is not scarred and marked in many places. They cut various devices about the body, raising the skin so that the pattern stands out like embossed work. This however, is not very general. Ornaments are suspended from the nose and ears. They are troubled with a parasitical disease which they call *Bakua* or *Tiripa*. It spreads rapidly over the body, and appears in the shape of scales a little larger than fish scales. This parasite has a strong objection to fresh water; the irritation set up by being out in a shower of rain is distressing to witness. Salt water does not seem to affect it so. We found that a mixture of sulphur and kerosene used as a paint speedily destroyed it, and when dead the parasite could be pulled off in large flakes.

Only at a place called Mioko and in one or two parts of New Ireland do the women wear any covering at all, and that only a very small apron made out of a kind of flax. In all other places all are quite nude.

The houses are small as a rule, but when so inclined the natives can make them well. The best houses I have seen are upon the east coast of New Ireland, where they are lofty and well built, and the village is surrounded by a stout stockade of bamboos. Usually the houses are about 20 feet long, 8 to 10 feet wide, and about 6 feet high at the ridge. They are frequently divided into two compartments, the first being the sitting and general room, where the fire is. The

inner room generally contains shell money and any valuables. Many of them are made by first erecting two parallel bars of the required height and distance apart. Strips of bamboo, reeds, or light branches of trees are used as rafters, one end of which is firmly fixed in the earth, and the top ends are bent over the two parallel bars and tied at the ridge. Battens are then tied across the rafters, and the whole, from the ridge to the ground, thatched with grass, which is not tied down as in Fiji and other places, but twisted in between the battens as shown by the accompanying rough sketch. It is the work of the women to gather the grass and bring it in, and the men thatch. The door is very narrow, so that a man has difficulty in passing through, and this constitutes a measure of protection. Around the sides of the interior of the house we frequently find wood stacked and tied, which serves the purpose of armour plating, and defends the sleeper or inmates from spear thrusts. Spears are kept handy in the ridge of the house, and other weapons are kept ready to hand. The house or houses forming the family group are surrounded by a fence made of the *bal bal*, a plant the branches of which readily take root in the ground. These are planted close together, and are made firm by tying strips of bamboo all along the row of plants. This forms a tolerably secure fence. Some of the houses are built with square sides and roof, as with us. The sides are made of plaited cocoa-nut leaves, or pickets made of bamboo or reeds; in the latter case they are decorated with considerable taste by a rather harmonious blending of their three colours, red, white, and blue.

In regard to house comforts and utensils the people are very poorly provided. They have no notion of pottery, their mats are of the poorest and roughest description, and they usually sleep with this poor apology for a mat under them upon the ground. In New Ireland we find them sleeping upon great slabs of wood, which is a decided improvement. Cocoa-nut shells, with long pieces of bamboo, are used as water-bottles, and to these must be added the water-bag made out of the banana leaf, toughened and make flexible by passing it over a fire. The possession of glass bottles is now becoming universal, and they are prized by the people. I have only seen one bowl made of wood, and that came from a distance. Knives were unknown until introduced by Europeans, strips of bamboo being used, and it is a disgusting sight to witness the dismemberment of a pig with these primitive knives. Prior to the introduction of tins and pots

all their cooking was done either by roasting upon the fire or baking in folds of the banana leaf in the oven, which is made as other South Sea Islanders make it.

As regards the food itself, most articles are common to all, but there are a few things which seem to be reserved for the women, viz., the dog, the iguana, and a certain kind of pudding, the latter seeming to be principally for mothers-in-law. Chiefs and men under certain vows in connection with a society called the *eniat* do not eat pork or certain kinds of fish, among which is the shark. The penalty for breaking this vow is enlargement of the stomach to bursting point, and other evils, ending in death. Fish, fowls, and small reptiles are plentiful, the wallaby and cassowary not so plentiful. In New Ireland there is fresh-water game to a limited extent. Pigeons and other birds in abundance, but the means of capture were primitive until the introduction of firearms. The people are cannibals, and though not to such an extent as other inhabitants of the South Seas, they carry it out in a very cold-blooded way, the portions of the victim being sold as we sell meat in the shambles, the purchasers quietly cooking and eating the flesh at home. Vegetables are plentiful. Bananas of many kinds form the staple article of diet, with cocoanuts in abundance. The yam, taro, sweet potato, a tender plant used as a cabbage, the bread fruit, the *kuru*—Fijian *wi*—pandanus fruit, sugar-cane, and various other fruits and vegetables—in short, both soil and climate unite to make the procuring of food an easy matter. A provident father will plant a number of cocoa-nut trees when a son is born, and in seven or eight years they form a large portion of the lad's living. As soon as the child can do anything he has a small plantation of his own.

The plantation work in its early stages is fairly divided between the men and women. The men clear the ground and burn off. They then turn up the clods and plant the bananas and other things. The women then go to work with short sticks beating the clods into powder, passing the earth through their hands, gathering the grass, roots, etc., out of the soil to be burnt. This method of weeding is very effective. From that time forward the plantation comes principally under the care of the women. Plantation work is usually done early in the morning.

The fish-traps I have described in a previous paper read before this Society. Their shell money and its uses, their marriage and burial customs, I have described in papers read

before the Anthropological Institute in England, and they have been printed in the journal of that Society.

Their canoes, considering their tools, are exceedingly well made, but are frail and they do not sail. In the north-eastern part of New Britain the natives make long canoes by very rudely hollowing trunks of trees, and then fixing large outriggers upon them. The New Ireland people make a kind of boat after the fashion of a whaleboat. It is strongly put together, but rather narrow. Both the canoes and boats are well managed, and make rapid and safe passages even in stormy weather.

The weapons of the people consist of spears and clubs of various kinds, the stone club being a terrible weapon. The bow and arrow is not known except as a toy for children, but the sling is a useful and a dangerous weapon. Pitfalls are dug, spikes placed in the path point upward, and spears cunningly hidden in the grass, making travelling dangerous in war time. Sham fights are frequently engaged in by the young people, who thus learn to handle their weapons.

The betel nut is largely cultivated and eaten in New Britain. It is eaten in the usual way with lime and the leaf and fruit of the pepper plant, the lime being carried in small bags which will hold about three ounces. It is slightly stimulating, but its chief attraction is, I think, its power to allay the pangs of hunger, and being taken frequently instead of food, the people suffer loss in physical strength. To possess a large number of betel-nut trees means a good income.

Tobacco seems to have been known in some parts prior to the permanent establishment of whites in the country. Soon after my arrival on the mainland of New Britain I saw a party from a place called Baining and they were smoking. The cigar was almost as thick as a man's wrist and fully one foot long. The party sat in the circle and they passed the cigar round. When smoking the man held it to his mouth with both hands, while another man sat before him holding a firestick at the other end. The smoker continued drawing in the smoke for at least a minute without emitting any. The cigar was then passed on to his neighbour. I watched the man, wondering what he had done with the smoke. Soon he began to send it out through mouth and nostrils until he was enveloped in quite a cloud of it, and so it went on all round the circle.

The inhabitants of the bush are quite a different race of people, the coast people evidently being invaders and con-

querors. The languages differ, and wherever possible, the coast people make slaves of the bushman. The sounds found in the bush language remind one of the sounds in Australian aboriginal language rather than of any other Papuan tongue I have heard of, but the features of the people do not resemble the Australian black in any marked degree. This is a subject worthy of strictest investigation by those residing on the spot, and no doubt it will receive due attention.

4.—SAMOA, &c.

By REV. S. ELLA.

In following the plan laid down by Dr. John Fraser for Reports on the Australasian, Papuan, and Polynesian races, I take up the Malay-Polynesian race on Samoa, and add also such information as I possess with regard to the Papuans inhabiting the Loyalty and New Hebrides groups, especially marking the differences in the manners and customs of these races which I have observed during a long residence among them. On the Island of Tai (called by mistake "Uvea")—my sphere of labour for twelve years—the two races are found, and to a considerable extent maintain their distinctiveness, though, both in language and customs, it is apparent that changes have been produced by intercourse one with the other. In this respect we see on a small scale what has extensively resulted from a more complete amalgamation of these races in Fiji.

Birth and Childhood.

With regard to the superstitious belief attaching to many old customs of the Polynesians, it is evident that the lapse of time and change of circumstances have erased this from the minds of the natives, so far as to render it difficult, sometimes impossible, to trace the origin and religious notions of many of their peculiar observances. The general reply to the question why such and such things are done is, "Oh, it is the custom of our people." In Samoa, for instance, it is considered a sufficient reason and information enough to satisfy all inquiry, "*O le tu faa-Samou foi*"—(It is just the Samoan custom).

In Samoa, when the woman was known to be *enciente* there were great rejoicings, not only by the husband, but also

in the families of both husband and wife; but the condition of the woman made no change in the intercourse of the married couple. In the Loyalty Islands (Papuan) the woman was then considered *tabu*, and the husband did not cohabit with her till some time after the birth of the child. In Samoa, the husband, sometimes in conjunction with the wife's father, would make offerings to the family god, praying that a favourable time might be granted to the woman, and that a male child might be born. Many promises would be made of what should be done for the god if he were propitious. The priest also was frequently visited, and valuable presents taken him to secure his intercession and favour.

The wife's mother, or some other female near relative, became the helper at the birth. Generally very little help was required; these children of nature often managed quite alone all that was requisite. The woman would go aside to some secluded spot in the bush, and after the birth would herself carry the babe down to the river or spring, wash it and herself, wrap the infant in some soft native cloth (*siapo*), and then return to the house. Some superstitious observances were practised with reference to severing the *umbilicus*; in the case of a boy it was cut on the blade of a club, with the view that the child should become a warrior; and of a girl the cord was severed on the board used by the women in beating out their cloth made from the bark of the *morus papyrifera*, that the girl might grow up to be an industrious woman.

For the first two or three days the mother refrained from suckling the child, but it was nourished by the juice of the cocoa-nut or sugar cane. The kernel of the nut was prepared by finely scraping, or it was chewed by the mother or a female attendant, and then placed in a fold of some fine native cloth and the juice expressed therefrom into the mouth of the babe. The mother continued to suckle her child until it was two or three years old, although it was taking freely of solid food. This foolish custom, among others, very much impaired the health and appearance of the Samoan women. When a child lost its mother in early infancy, it was very difficult to obtain a woman to nurse it, from a superstitious notion prevailing that the child of the nurse would die in consequence.

Infanticide, so prevalent in the westward islands, and ages ago in Tahiti, was not practised in Samoa. Abortion was frequently produced mostly by unmarried females. Various expedients were resorted to for this horrid purpose, as in the

New Hebrides and Loyalty Islands. On Tanna, and other volcanic islands of the New Hebrides, the women would bathe in the hot sulphurous springs for this purpose. Deformed and sickly children are in nowise objects of aversion to their parents; such often receive more affectionate attention on that account. In Samoa, hunchbacks, who are very numerous through scrofula, were looked upon as special favourites of the spirits (*aitu*). Many of these, when grown to manhood, were received as priests of the spirits (*taulaitu*).*

Naming.—The child was often named after the household god, or from some special attribute or legend connected with the god. Generally the name of an influential member of the family, by permission or appointment of such member, was given to the child. Frequently from some public event, or even a trivial circumstance occurring at the time of its birth, the child would receive a name bearing on the subject. In the Loyalty Islands, as in some parts of South Africa, after the naming of the child the mother drops her own name, and is thenceforth known by the name of "Mother of so-and-so," whatever the child may be called. Names were frequently changed during a lifetime.

In infancy the babe is borne in the arms of the mother, leaning on her bosom, or carried in a girdle suspended from the neck of the nurse; and when strong enough to sit up, the child is carried outside on the mother's hip supported by her arm. The Samoan mother and relatives are anxious that their children's nose and forehead should be flat, which is considered by them a mark of beauty, and the reverse a defect, and they repeatedly use pressure to secure the desired effect, by compressing the child's nostrils with their thumbs, and bearing the thick end of their palms on the centre of the forehead. The father often nurses the babe and lavishes caresses on it. The Papuan father, as in the Loyalty Islands, took the chief charge of the babe, for the mother was required to cultivate the plantations and do all other drudgery for the household, leaving the babe in the father's care: he would nurse the child, feed it with cocoa-nut juice or sugar-cane syrup, and otherwise attend to its wants.

Parents manifest great affection for their offspring, and are particularly careful and anxious about their physical health and development, but very little concern is shown for their moral training. Children were left to follow "their own

* During the whole time of my residence in Samoa, I had such a one in my employ, who formerly was considered a very sacred being.

sweet will," without much restraint or discipline. The almost universal system of adoption also operated against parental control. Although the adopted child would be treated with affection and care, the adoptive father and mother would refrain from exercising any rigid control or discipline, lest the child would leave them and run away to its own parents. This adoption was often made with the view of obtaining property from the parents' families; and those adopting children were also expected to make presents of property to the family of the adopted child. Girls were very early initiated into the domestic duties of women. In Samoa these were comparatively light, but among the Papuans all hard work and drudgery were performed by the females of the family, and even little girls had to slave in the plantations and fields from dawn to dark.

Early betrothals were rare in Samoa, but in the Loyalty Islands and the New Hebrides children were betrothed often in infancy, and when the girl was strong enough she had to plant and cook for her betrothed husband, a child like herself. In Samoa an abominable practice existed: a chief or priest or other influential person would bespeak a child, and when she reached the age of puberty, she was taken to him, or he would fetch her to his home, and she became his secondary wife or concubine.

Maturity.

Youths reach maturity at an early age—boys at fifteen or sixteen, and girls at thirteen or fourteen. Boys are circumcised at eight or ten years of age. Two or three lads about the same age would agree to go together and have the rite performed, not, it appears, from any religious notion, nor was any religious service connected with it. The idea of cleanliness or manliness was the only object for its observance. The operator was a native or Tongan surgeon. The operation was performed with a sharp bamboo knife. The *præputium* was simply incised, and brought down to the *corona glandis.* Circumcision among the Papuans is practised in some islands of the New Hebrides, but not in any of the Loyalty Islands.

On the first appearance of the menses, a girl is taken under the care of a near female relative, and instructed in necessary arrangements, especially in regard to health. The female friends will make a feast to the girl, and there is more or less rejoicing. The aid of the family deity was besought, and prayers offered that the girl might be kept pure and

healthy, marry well, and become the fortunate mother of children. The girl was then more strictly watched and guarded.

In Samoa, tatooing (more properly called *tatau*) was universally observed by the young men as an initiation to manhood rights. Girls were not tatooed. It was originally introduced from Fiji. A legend states that two Fijian goddesses, Taema and Tilafainga, swam to Samoa from Fiji, and on reaching land sang, "Tatoo the men, but not the women." The tradition says that they intended to direct the reverse, for in Fiji women are tatooed and not the men, but in their haste they issued a contrary order, which has ever since been observed. Among the Papuans the women are tatooed or cicatrized, and not the men. Girls are tatooed at various periods on New Guinea. (See Rev. J. Chalmers' paper read at Melbourne in 1890). The tatooing lancets were made from a flat piece of human bone of the *os ilium*, and somewhat resembled a small toothed comb, with a cane handle. The colouring matter was a mixture of burnt candle-nut (*Aleurites triloba*) ash and water or oil, into which the lancet was dipped, and then struck into the skin with a little wooden hammer. Various patterns were followed with remarkable accuracy. Some of these patterns denoted the clan to which the young man belonged, like a Highlander's plaid. A considerable time was spent in the process of tatooing, for only a portion would be done at a time, as far as the patient could bear the torture of the operation. The operator was well paid for his work. A good deal of feasting and revelry, and often immorality, took place during the event. The tatooing was on the lower part of the body only, entending from the waist to the knees. When a young man was tatooed he was considered eligible to take his place as a warrior, and mingle in the dances and assemblies of the people, and drink *kava* with the elders, if so disposed, though kava-drinking was confined chiefly to elderly men, and taken by them only to a limited extent.

No particular ceremony was oberved as an initiation into the tribe; birth, or adoption, or the bestowal of the name or title by an important member of the tribe entitle the subjects to be members. In the case of young chiefs, superior and inferior, before they could be eligible to speak at the councils (*fono*) they had to be well grounded in the genealogy of their progenitors and also of the chieftains of other tribes, and into the various titles and patronymics given to these.

For this purpose there were teachers provided who were familiar with these matters and with the legendary lore contained for the most part in their ancient songs and myths.

A bachelors' establishment was common in the Loyalty Islands, consisting generally of a large house erected outside of the village, where the young men clubbed together and resided apart from their families. The club was composed chiefly of those who either had not been betrothed in childhood, or whose betrothed had died, or had been taken away from them ; and so, at a time when polygamy existed, they considered themselves doomed to celibacy.

Marriage.

Child betrothals were not practised in Samoa, nor were marriages made by force, and rarely by capture. Occasionally a chief would take into his house a secondary wife, or mistress, from a conquered tribe. Although there was no such thing as purchasing a wife, yet marriage engagements were too commonly matters of barter, and often formed with no other object than as a means of interchange of property between the families of the alliance. The bridegroom's friends provided the *oloa* (foreign property), which consisted of pigs, canoes, and foreign cloth, clothing, &c., guns, tools, and other imported materials. The bride's family collected for the occasion fine mats used as dresses, native-made cloth, mosquito drapery, baskets, fans, and ornaments which are the work of women, and termed *tonga*.

The preliminary arrangements are peculiar. A young man seldom pays his addresses in person, even where mutual attachment may exist. A friend (paranymph) is obtained for this purpose, who conveys a present of cooked food, generally composed of a pig and vegetables, which takes the place of a love letter, to the maiden ; and the friend then has an interview with the girl's father or guardian, and sometimes with the girl herself. Should the present be received and eaten, it is considered a sufficient and favourable reply. Then the collection of bridal presents (more properly barter) is at once set about by both families, and a day is fixed for the marriage. Should, however, any of the friends of either party object to the union, they will show their disapproval by refusing to collect property for the occasion, and in that case the marriage may be deferred or broken off. This may result in the girl's running off with the young man to settle in another tribe ; or the bridegroom may leave his own family

and take up his abode in the woman's family, in which case he sinks his dignity and becomes a serf or underling in the wife's household. These events were often the occasion of family feuds, and not unfrequently of intertribal wars.

In ordinary cases the marriage celebration was a very simple affair, and conducted without much parade or ceremony; but in the case of either party being a member of a chief's family, the celebration was of an ostentatious and public character, accompanied with feasting and revelry, which continued for several days. On the day appointed the bride and her relatives and friends would assemble, with the *tonga* they had collected, in the village of the bridegroom, and the friends and family of the young man did the same, with the *oloa* they had provided for the auspicious event. A large gathering would meet in the *marae*—the open space in the town or village for all public business. The bridegroom, decked for the occasion, seated himself cross-legged, in Samoan fashion, in the centre of the *marae*; the bride then emerged from an adjacent house dressed with a profusion of fine mats dependent from her loins and trailing in a long train behind, her body well anointed with scented oil, her chest, and neck, and head ornamented with necklaces and garlands. She was followed by a number of maidens adorned with fine mats, &c. They would move in procession to the bridegroom, and deposit the fine mats before him. The attendants then withdrew from the bride; and a truly heathenish custom followed, which will not bear description.

The feasting, dancing, and nocturnal orgies were carried on for some days. Before separating, the property was divided among the friends by the father or paternal uncle of the bridegroom, who distributed the *tonga*, or dowry; and by the father or brother of the bride, who divided out the *oloa*.

An evil custom existed in Samoa, grossly immoral and fraught with much mischief. Among young chiefs of good appearance were some who were termed *manaia* (beaus). Whether single or married, a temporary alliance was arranged with young women. With much display, and with the consent of the families of each, the *manaia* was taken to the house of the belle, and they would cohabit for a time. The usual interchange of property took place as on a lawful marriage. This seems to be the main object of the vile transaction.

In the Loyalty Islands, and, I think, among the Papuans generally, marriages were conducted with very little ceremony or demonstration. Betrothals having been made in early life, perhaps in infancy, and being constantly kept before their minds by the girl having to work for her destined husband as soon as she was able to perform the toil required, marriage was a settled matter calling for no excitement. When the time arrived that the friends thought it right that the betrothed should live together, or the young man should decide for himself, little else was necessary than they should convey his wish to the girl and her family, and then the youth would fetch her away, or she would be brought to him *nolens volens*, sometimes by force and ill-treatment. A feast was provided for the occasion by both families, of which all present partook, and "portions" were sent also to relatives living at a distance. Betrothals can be annulled, but only with the consent of the young man and his family, and payment exacted, often very considerable. If the engagement is broken without such arrangements a deadly feud is likely to result, and a heavy penalty is demanded by the young man and his relatives.

Polygamy existed in Samoa, but only to a limited extent, and was almost restricted to high chiefs. Children were mostly, though not invariably, included in the father's tribe. If the mother belonged to a superior tribe to that of the father, the children would probably be adopted by members of the mother's family, and, in that case, take their political position in that tribe in peace and in war.

Polygamy among the Papuans is very general. Chiefs possess several wives, or, more properly, slaves or labourers. Among the inferior classes a man rarely had more than two wives, and some remained bachelors.

Land was held by tenure of inheritance derived from the original possessor, and was divided and subdivided as families multiplied. Some holdings were possessed by gift or purchase. It was in the power of chiefs, or a council of chiefs, to dispossess a man of his land and even to expel him from the tribe and district. Among the Papuans, as in the Loyalty Islands, land under cultivation was the property of the females who cultivated it; its alienation, however, was subject to the approval or otherwise of the heads of families and chief of the tribe or district.

Widows and orphans were treated with compassion and kindness. A widow was at liberty to return with her children to her own family. There was no obstacle interposed to

prevent a widow marrying again. This liberty was probably not granted to widows of high chiefs.*

Among the Papuans in the New Hebrides it was the custom to strangle the widow on the death of the husband, that she might accompany him to the shades. The Loyalty Islanders spared the widow that ordeal, but she was under restraint not to marry again early, and not without the consent of the deceased husband's family. Then she was not at liberty to claim the children. In her widowhood she might obtain permission to return to her own family and tribe, but she was required to leave her children in the husband's family.

In Samoa both males and females have full liberty to marry into any family or tribe they choose, though dignity of station is generally observed. They avoid connection with near relatives. In former days, in many cases, a younger sister would accompany the bride to her new home, and become a secondary wife to her sister's husband. In the Loyalty Islands there was little reluctance to consanguinity, beyond congenital members of the family, in forming a union. A remarkable deference was observed between brothers and sisters even in ordinary social intercourse. Marriages were rarely made outside of their own tribes, probably with the intention of retaining the land within their tribes. Many physical evils may be attributed to this custom.

The Samoan treats his wife, and women generally, with courtesy and kindness, and considerable chivalry. In their heathen state, however, the marriage tie was observed only so long as it suited the will or disposition of either party. No bill of divorcement was necessary for a separation. The man or wife might say to the other, "Your love to me is ended, so is mine to you—let us part," and that was considered a lawful dissolution, and on sufficient grounds.

The work of a married woman in Samoa is comparatively light. She has the care of the home and the children, the manufacture of native cloth, mats, &c. She keeps the ground around the house well weeded and clear of leaves and rubbish. Occasionally she will help in planting and in fishing—especially collecting crustacea and shell-fish. The "sewing" of thatch is the work of women. A wife accompanies her husband to the wars, and bears a reserve of arms for him in the fight. The Papuan wives have a very hard

* The two widows of the famous Malietoa of John Williams' time lived near my residence for some years. They continued in widowhood, and I was informed that it was considered *sa* or *tabu* against their marrying again.

lot: all that may be called work is performed by women, even to the bearing of heavy burdens; while the men consider that fighting, fishing, and voyaging constitute their equal portion of life's cares. The Samoan shows some gallantry and respect to his wife; but the Papuan treats his wife with contumely and harshness, often beating her with savage brutality, and for a slight cause will kill her without much compunction.

The Tribe.

The several tribes were constituted by the families who were lineal descendants of the original possessors of the country, probably conquerors of an earlier race, who were extirpated or driven out before them. These tribes, at first, were pure and distinct; but in the course of time some amalgamated, and others were divided by certain families separating from their respective tribes and forming distinct tribes under the elders or leaders of the secession. This latter change occasionally arose from family quarrels, but chiefly through emigrations to found settlements in other parts of the country. These emigrants retained their fealty to the head chief of the original tribe, and were governed by him in time of war, or in any important political movement; in other respects they were independent, and under the control of their own appointed head.

Samoa is not only divided by several islands (eight), but the people of each island are also separated by distinct political divisions, or districts, each embracing several tribes, with a large number of chiefs, primary and secondary, termed *ali'is* and *tulafales*, similar to the *arikis* and *rangatiras* of the Maories. In some of these districts, as on Upolu, a superior or head chief resides, bearing the title of king, claiming obedience and deference from all other chiefs of the district. These, the Tui-Aana (king of Aana), and Tui-Atua (king of Atua), are recognised as lineal descendants of some of the ancient head chiefs. In addition to these there are families almost as highly distinguished, such as the Tupua family, of the Atua district, and the Sanga family, of Aana.

Each political division contains some principal villages or capitals distinguished by a combination of chiefs or heads of families, who in some degree control the affairs of the entire district. These capitals bear the titles of *Tumua* and *Laumua*, denoting their primacy and superiority. Le-ulu-moenga, the capital of Aana, is also distinguished by the title of Fale-iva (nine houses), denoting the nine principal chiefs who rule

there, and in a large measure direct the movements of the Aana district. Other important villages are in like manner distinguished by the heads of tribes or chiefs ruling there.

It is evident that the heads of families of the original possessors of the land became chiefs, whether they were so prior to their occupation of the islands or were constituted such on their settlement. Similar promotion is seen at the present day in members of families forming new settlements. The Rev. John Williams, the earliest Englishman who held close intercourse with this interesting people, was struck with the polished manners of the Samoans, and with the fact of their possessing a chiefs' or court-language, and concluded therefrom that among the first immigrants of Eastern Polynesia Samoa was settled by the chiefs of these Malay settlers.

The "Genealogy of Kings and Princes of Samoa," given by Rev. G. Pratt, and printed in vol. ii. of the Proceedings of the Association, pp. 665-663, compares in many respects with a Maori Genealogy, and supplies traces of the several Samoan dynasties. From this Genealogy it may be gathered that, in the early history of Samoa, Atula and Aana, the eastern and western districts of Upolu, were paramount in the ruling power. Subsequently this position was reversed by conquest, and, under the Malietoas, Manono and Savai'i became supreme *Mulo* (conquerors). The conquered tribes (*toilalo*) were treated much like slaves by the victors, and were for a time held in intolerable subjection.*

* In 1848-51, during a three years' war, Aana and Atura struggled to regain their position. They were able to establish their independence. On the death of Malietoa, his brother, Moli, father of the present Malietoa-laupepa, declined the honours of kingship, and an uncle, named Pea, was chosen by the Savaii and Manono chiefs to be king; but nearly the whole of Upolu preferred the son of Moli. A war resulted, which was patched up by an armistice, with an agreement that the uncle and nephew should reign unitedly, as an Augustus and an Antony, and that the young king Malietoa-laupepa should rule supreme on the death of Pea. Owing to disturbances occasioned by an American adventurer, who, it was supposed, was supported in his designs by the United States Government, great bitterness was introduced into the family feud, and animosities engendered and intensified among the several tribes throughout the group; this produced a succession of intertribal wars. Through the intervention of the British and American consuls and commanders of ships of war and of these nations peace was restored, and a parliament formed somewhat on the basis of a House of Lords and a House of Commons, and a municipality was instituted at Apia, the chief port and foreign settlement. Another claimant to the dignity of kingship was Tamasese, a son of Moenga-ngono. He was put forward by some tribes of Atua and Aana, and, during the contention, was recognised by the German consul and other officials in opposition to Malietoa-laupepa. On the arbitrary deportation of Malietoa-laupepa by the Germans, Mataafa, the recognised king of Atua, was supported by Atua and Letuamasanga (the

The office of chief is considered hereditary, though in many cases the chief nominates his successor, generally a son or a near relative. Sometimes the title will be conferred on an adopted son. Failing a male heir, a daughter may be appointed to, or she may assume, the prerogative of chieftainship. The appointments are subject formally to the assent of the tribe. Occasionally a clan will select its own chief, or sever its connection with its own tribe, and unite with another. This occurs through quarrels, or where there exists an objection to the family of their late chief or to his appointed successor.

Kings in ancient times were publicly proclaimed and recognised by anointing in the presence of a large assembly of chiefs and people. A sacred stone was consecrated as a throne, or rather, stool (*scabellum*), on which the king stood, and a priest—who must also be a chief—called upon the gods to behold and bless the king, and pronounced denunciations against the people who failed to obey him. He then poured scented oil from a native bottle over the head, shoulders, and body of the king, and proclaimed his several titles and honors.

The powers and prerogatives of a chief in the ordinary affairs of life are little more than nominal, although he receives outward marks of deference and respect from his subjects. The government is almost democratic, and, for the most part, each man acts according to his own will. The principal duties of a chief consist in administering municipal laws, settling disputes, punishing transgressors, appointing feasts and general tabus, and in leading in war. In the time of war the dignity of chiefs is in the ascendant, and, although little deference may be shown him on ordinary occasions, he then becomes of importance, and more attention is paid to his authority; still, even then, it is almost impossible to maintain strict discipline.

Among the various marks of deference shown to a chief are those of designating him by the several titles of the family or tribe, addressing him in chiefs' language, and by always

central distaict of Upolu, and Malietoa adherents to oppose Tamasese. This brought on a conflict with the Germans, and would probably have involved serious troubles to the whole of Samoa; but the evil was prevented by the prompt and determined action of the United States Government. As a result of the conference between the Governments of the United States, Germany, and Great Britain, Malietoa-laupepa was restored to power, and a tripartite protection accorded to the Samoans, which is the present position of the Samoan Government, and alters very materially the ancient régime. It is to be hoped that a stop is now put to the constantly recurring struggles for supremacy.

taking a stooping or sitting posture in his presence. Certain articles of food were specially set apart for him; certain fish, &c. were claimed by him and tabu; and the first cup of *kava* at feasts was presented to him by right of precedence. In travelling by land he walks at the head, and, by water, a seat is provided for him in the forepart of the canoe.

Chiefs mingle freely with their followers in their daily duties, and will work as an ordinary person in the plantations, in hunting and fishing, and in house and canoe building. If the house or canoe be for himself, he will probably quietly sit among the workers (*tufuga*), conversing with them or cheering them on in their operations. He will see to providing food for them and the payment required during the progress of the work.

In almost every Samoan village there is a place of council (*marae*), an open green spot within a circle of houses and trees. The centre is occupied by a large house belonging to the chief, and set apart as a caravansary for the entertainment of strangers and visitors. In these *maraes* the parliament and councils meet and transact public business, both that of the separate communities and also of more public and general affairs. The council is open to all the leaders of the community for free discussion and deliberation—to the *faipules* (chiefs and rulers) and *tulafales* (heads of families). Great decorum is maintained in these conferences. Certain rules are strictly observed, and any infractions would be considered insulting, or at least, a boorish rudeness. Kings and high chiefs had their own orators, and seldom spoke themselves at the councils. At the opening of a debate probably three or four would arise together to speak (as a mere matter of formality), and then each would quietly recount his family pedigree in genealogical order. In due course one after the other would resume his seat, giving precedence to his superior, until the highest would be left in possession of the field, and open the debate, addressing each chief present, or represented, by his various titles. Not a man or an animal would be permitted to cross the *marae* while the speaker was engaged in his harangue. The only interruption that was pleasantly tolerated was from the arrival of food which had been provided for the chiefs in the assembly. This food is brought in by the women and young men and boys and girls in orderly procession, and taken, in the first instance, to the principal chief, who will send portions to one and another present; and those receiving it will, in like manner divide out to others.

These friendly hospitalities often produce a happy effect: many family quarrels and old feuds and long-standing animosities have been wiped out on such occasions. Sometimes, however, an opposite result has been produced. Perhaps by accident, more frequently from ill-feeling and jealousy, the proper portion, in accordance with Samoan etiquette, has been withheld from a chief expecting to receive it, and sent to another not so entitled to the mark of dignity. This neglect would provoke an angry and resentful feeling in the minds of the offended chief and his followers. Feuds and wars have arisen from such a slight cause—slight in our estimation, but a very serious matter in their ideas.

Parliamentary councils are held in the principal village or town of the district, and they are attended by all the chiefs and head men of the district. At these assemblies the more important affairs of the commonwealth are considered, laws are made for the regulation of the community, and war and peace settled in these deliberations. On a declaration of war messengers are despatched to all the villages, who simply run through the villages, adorned with long yellow streamers and bearing such streamers flying from a spear-point. This was a sufficient intimation, and in a very short time the clans assembled in the chief village.

At the *fonos* (council) public offenders are arraigned and their punishment adjudged. Law was administered in a very loose and irregular manner; for the most part every man was a law unto himself, and did what was right in his own eyes. An injured party would become his own judge, jury, and executioner. Blood-revenge was insatiable until a victim had been obtained to appease the thirst of vengeance—the *taui-ma-sui* (reward and substitution).

The tribes of New Caledonia and the Loyalty Islands, as far as can be judged from lack of historical or legendary information, were formed by family divisions among the original proprietors of these islands. A wide diversity in their languages, yet bearing some slight marks of affinity, gives ground for supposing that they did not come from a common stock, though their ancestors may at some distant period have been related. The races are not so broken and distinct as among the inhabitants of the New Hebrides.

There are not so many chiefs comparatively as in Samoa, and those which exist possess more power over the tribes, and are more despotic and tyrannical. The office is hereditary, and the people have no voice in the matter. If a

tribe should have a quarrel with its chief it cannot depose him, but it can pass over to another tribe and be amalgamated with it, or it may still retain its identity and remain simply as refugees, and is at liberty to return to its own land at a future date.

On Uvéa (Tai), of the Loyalty Group, the dominant tribe was defeated in a general insurrection of the inferior tribes about fifty years ago, and was nearly exterminated. The survivors fled to New Caledonia, and have formed a distinct tribe there on the north-east of the island, at a place called Yengen. On the north and south peninsulas of Tai reside tribes of castaways of the Malay-Polynesian race from Uvéa (Wallis' Island) and Tonga. By the former, that end of the island is called Uvéa, which name has mistakingly been given to the whole island, and the southern end is sometimes called Tonga from a similar reason.

Social and Domestic.

Among the Samoan people there is an amount of refinement and civilisation not to be found in any other part of the Pacific, and these are apparent in their social and domestic life. Their houses were of a superior construction, not mere huts of rough materials, and remarkable only for largeness of size. Housebuilding is an established trade, confined to certain families, and affording considerable emolument and privileges to the craftsmen. The best houses are constructed chiefly of the wood of the breadfruit tree (*Artocarpus incisa*). Two (sometimes three) large central posts form the main supports, capped by a strong ridge-pole, from which descend a number of light rafters fixed to the wall-plate, which is in a circular, sometimes oval form, and upheld by a circle of posts or studs, from four to five feet out of the ground, and about four feet apart. The roof is encircled by a series of parallel bearers about three inches thick, fastened to the rafters by sinnet. Over these, from the ridge-pole to the wall-plate, is an elaborate covering of fine rods, like the bars of a cage, an inch or so apart, made of slips or laths of breadfruit wood joined together with neatly formed knotches, bound with fine sinnet. No nails or spikes are employed in the building. All joints are made by exactly corresponding knotches, and secured by layers of sinnet worked in orderly and artistic form. The thatching is made of sugar-cane leaves, fastened on reeds in five feet lengths. The space between the posts

of the house are enclosed with a folding matting of cocoanut leaves, which can be drawn up when required, something like a venetian blind.

The best houses in New Caledonia and the Loyalty Islands are of a pyramidal shape, smaller in circumference but much higher than the Samoan. Both the roof and sides are closely thatched with long grass. There is but one aperture, a doorway four feet high. The roof is crowned by a finial of a fantastic figure, and the sides of the doorway are ornamented with thick slabs of wood, on which are carved grotesque representations of human figures. The interior of these abodes are very dirty, and begrimed with soot. Both in Samoa and the Loyalty Islands there are other houses of lighter construction.

In a former paper on "A Comparative View of some of the Customs and Social Habits of the Malay and Papuan Races of Polynesia," I have briefly described the houses erected on New Guinea and the New Hebrides.

In a country like Samoa, where climate and soil are most favourable to vegetable growth, and where perennial showers and seasonably dry weather recur in regular order, and where very few destructive elements exist, food is abundant, and cultivation is conducted not so much from necessity as from a desire to obtain a variety of edibles. Cocoanut, breadfruit, and chestnut trees, and wild yams, bananas, plantains, papaw apples, melons, pumpkins, and other esculents abound throughout the islands, requiring very little attention for reproduction. Taro, yams, sweet potatoes, and certain species of bananas, with several introduced vegetables and fruit trees, are all that demand labour from the people.

In Samoa the cultivation of the soil is the work of the men, with the occasional assistance of women and children. The agricultural instruments employed are of a most simple and primitive order. In place of a plough they use a wooden dibble, and instead of a harrow a branch of a tree is made to suffice. Sometimes the earth is dug up and made smooth with the blade of a canoe paddle. The removal of weeds and other noxious growths receives the greatest care, so that a properly cultivated plantation looks as clean and orderly as a Chinese garden. Where food is so abundant the natives are all well nourished.

In addition to the cultivation of the soil there are various other occupations giving employment to the people. Of skilled labour, house carpenters and canoe builders, fishing-

net and fish-hook makers, surgeons and tatauers form distinct crafts, confined to certain families, where a rigid monopoly is maintained. Among these craftsmen several subordinate assistants are retained, who in course of time become masters. There are also lower helps, who are employed to cut wood and plait sinnet for the carpenters, prepare the cord, &c. for the net-makers, and seek medicinal herbs for the doctors. The women have their own occupations, followed with more or less skill and industry in all their families, such as the manufacture of fine mats to be worn as rich clothing, and the coarser sleeping and house mats, and native cloth made from the bark of the paper-mulberry (*Morus papyrifera*), beaten out on boards with a grooved beetle. The sound of these beetles ringing upon the boards, though not very musical, is pleasing, as denoting health and peace prevailing in the village.

As a rule the Samoans had but one definite meal a day—at evening, about six o'clock. They did not fast in the interval, for where fruits and edible plants so extensively abound the natives were always regaling themselves with one thing or another. Cooking is performed by men, women, and children indiscriminately ; all helped in some part of the operation. The cooking shed was placed a little distance from the house at the back. The native oven was a simple construction, a hollow in the ground, lined with stones (blue metal). This was filled with firewood sufficient for the purpose, and upon the firewood other stones were placed, and the fire lighted. The stones were all red hot by the time the wood was consumed. The upper stones were then removed to the side, the ashes swept out, and the food to be cooked, wrapped up in breadfruit or banana leaves, was placed in the hollow and then enclosed with the stones just removed. The whole was covered over with leaves to keep in the heat. In a short time the food would be well cooked—fish, pork, vegetables, &c., whatever may have been provided. It was then withdrawn from the oven and spread out upon the breadfruit leaves, and borne into the house upon a tray of plaited cocoanut leaflets. The members of the family would sit around this tray or against the outer posts of the house, and their portions of food were borne to them by the women of the family, under the direction of the head man or his wife. Samoans are exceedingly hospitable, and visitors are welcomed and liberally entertained. The best and largest portions are appropriated to such guests. A neighbour or a

stranger passing near the house at the time of the meal would be cheerfully invited in to partake with them.

Samoans do not wear ornaments in any profusion. The men are proud of their tataued limbs and head of long hair. The hair is mostly gathered up in a knob on one side of the head. As a mark of respect, in the presence of a superior they unfasten the cord and let the hair flow down. The clothing of males was a girdle of dracæna leaves, sometimes very scanty. The women wore a longer girdle or a wrapper of native cloth. On state occasions they put on their fine mats, and ornamented their necks with a circlet of scented flowers or a necklace of shells or pandanus seeds. Sometimes they covered the forehead with a pretty coronet made from the innermost septa of nautilus shells in a double row. Girls were fond of wearing flowers in their hair, and tucked behind the ears. The heads of boys and girls were often shaved closely, just leaving a few locks pendent on the side of the head. The figure of the Samoans is commanding, tall, and well-nourished, with well-formed features.

The Papuans of the Loyalty Islands are far less sociable than the Samoans, and live more isolated. The women were little respected, and often barbarously treated. Upon them were imposed all the labour of the household, the cultivation of the soil, and the bearing of heavy burdens. Their position in the family was a degraded and isolated one. They took their meals apart from the males, and had to wait till the "lords of creation" were satisfied, and then be content with what was left for their repast. There was very little kindliness or hospitality shown in their social intercourse. They were less cleanly in their habits and in the preparation of food; the ovens were covered in with heated earth instead of stones—probably from lack of basalt, and coral stones are utterly unsuitable for the purpose. The natives are a hardier people than the Samoans, though not so well nourished. Times of famine or great scarcity were of frequent occurrence, and borne with patient endurance.

The Loyalty Islanders wore no clothing except a headdress. They perforated the ears, and wore sticks, rings, feathers, or shell ornaments in them. Some carried a small shell in the septum of the nose. The married women wore a narrow fringe around the hips, and ornamented their arms with white cowries, rings of tortoise shell, or pearl shell, and their necks and chests with strings of small shells or scented vines.

Wizards.

Though somewhat given to necromancy, still Samoans were comparatively free from the all-pervading superstition of witchcraft which so extensively prevails among the Papuan race. In Samoa there were men (sometimes women too) who were supposed to hold intercourse with spirits (the *aitu).* These *taulaitu*, the media of the *aitu* in some points resembled the Roman *augures*, and were able to foretell future events. They acted also as the media or intercessors with the totems and tutelary deities, and received the offerings made to such. The office was hereditary and belonged to chiefs in some cases, or members of a particular family, but not limited to these. It was often taken up, or given, on account of some malformation, or from a striking peculiarity in temper or disposition. Hence, many hunchbacks were *taulaitu*, and epileptics, who were considered as possessed of an *aitu*.*

The *tabu* system in Samoa is employed chiefly for the purpose of protecting the native plantations and fruit trees from depredation by dishonest people. Each individual is supposed to have this power of tabuing his property, and bringing punishment on those who disregard it. Without the aid of the *taulaitu* he will imprecate a curse on those robbing him, and it is thought such imprecation will bring evil on the perpetrator of mischief to his trees or plantation. He will mark the nature of his *tabu*, or curse, by some significant symbol.

The Papuans are more given to witchcraft and the belief in wizards than the Malay-Polynesians, and live in abject terror of these. Remnants of food and rejected scraps are carefully collected after a meal, and immediately burned or buried away secretly, as the use of these is the means by which the wizard exercises his supposed power of sorcery. Every alarming sickness, or accident, or death, was attributed to the effects of sorcery; and suspected persons have been murdered in revenge for the injury inflicted. Several missionaries and native teachers have been murdered in the New Hebrides through this dark superstition; their books, their writing, and their prayers were considered as means of sorcery.

On the Loyalty Islands, the influence of evil spirits (*uneuthua*) was much dreaded; sudden death and other calamities were viewed as the result of bewitchments, and the

* The only female *taulaitu* I knew was an epileptic.

acts of the evil spirit; also miscarriage, difficult parturition, fatal child-bearing, and cases of malformation or of *nævi materni* were supposed to be caused by such demoniacal influences. At such times, searching inquiries would be made as to who had provoked the anger of the *uneuthua*, and often confession was made of some transgression which had provoked the ire of the spirit. If a canoe were overtaken in a storm, or driven astray by adverse winds, the crew, like that of the Phœnician vessel in which Jonah was escaping, would demand mutual inquiry as to whose guilt had brought them into danger. Some startling revelations have been made on such occasions.

Death.

Sickness and death were viewed by the Samoans as proceeding from the anger of their tutelary deities, or produced by an evil spirit, or by the spirit of a dead relative entering the body of the victim. According to native accounts, men and women formerly enjoyed greater longevity than at the present time. There are no means for verifying this statement, as there are no data by which it is possible to ascertain correctly the age of individuals, for their mode of computing time was by tracing back remarkable events—such as famous wars, &c.—as having occurred in the lifetime.

When a member of a family was seriously ill, messengers would be sent with presents to the priest (*taulaitu*) to inquire the reason of the displeasure of the family god or *aitu*, and to supplicate his clemency and forgiveness. At such times the cupidity of the priest would be successfully manifested, and the most valuable property would be demanded and willingly surrendered, as offerings to propitiate the god or *aitu*. The priest would cunningly quote, or invent, some family curse existing, or a case of transgressing against a tabu.

Friends and relatives of the sick would visit him, even from distant places, each bringing a present as a token of regard; and after the funeral rites were performed, these presents were distributed among the mourners and friends assembled on the occasion.

There were surgeons and doctors among the Samoans who practised mostly with charms and incantations. The Tongan doctors, a large number of whom found a remunerative practice in Samoa, employed medicines—chiefly decoctions of herbs, often very successfully, in acute diseases. Massage was repeatedly practised, with very soothing effect, also anointing

with oil as a remedy in some complaints. The native surgeons would often perform very rough and barbarous operations. Should the patient die of an hereditary complaint, or if it were apprehended that the disease would descend to the children, the body was opened, and a *post mortem* examination made for the disease. Any part or organ having an inflamed appearance was removed and burned; and they supposed that then the complaint would be stayed in its progress to any others of the family.

As soon as the breath left the body, and even when the patient was *in extremis*, loud lamentations and expostulations, and sometimes bitter reproaches, were set up around the body, as at an Irish wake. Some mourners would tear their clothes to pieces, some would pull out their hair by handfuls, and some would beat and bruise themselves with stones, &c., and others would cut and gash themselves with sharp stones, shells, and sharks' teeth, until their bodies were covered with blood.

Funeral obsequies were observed with considerable parade. The house was abandoned for a time to the dead and one or two near relatives. No food was eaten in the house, all meals were taken in a spot outside, under the trees, or in an outhouse. Those who handled the corpse in any way were *tabu*, and were not allowed to feed themselves, or touch any food with their hands. They either ate their food as spread for them on mats, or were fed by the hands of others; and were restricted to one meal a day, at nightfall. Generally the body was buried within twenty-four hours after death. In the case of chiefs or influential members of the tribe, the body was kept out of the ground for four or five days—"lying in state"—to enable friends at a distance to visit it, and to be present at the burial.

The body was clad in the best clothes and ornaments of the deceased, wrapped up in native cloth, or placed in a coffin made from the body of a small canoe, with the ends cut off, and the spaces filled up by boards. Scented flowers, beans, and seeds would be placed around the spaces within the coffin. The coffin was then enclosed by wrappers of new native cloth and borne on the shoulders of male friends to the grave. Cemeteries were unknown. The graves of a family were, as a rule, on the family grounds near to the dwellings. The graves were carefully dug in the earth or sand, the bottom was covered with sleeping-mats, and the coffin gently laid on the mats, as for repose. For a chief or man of distinction fires were kept burning day and night in a line from the

house to the grave. The reason assigned for this custom was to keep away evil spirits.

Graves were enclosed with neat piles of stones, and often covered with fragments of coral and shells. Of chiefs and other distinguished men, the grave was surmounted by a mound of stones, having the appearance of a vault. The resting places of the dead were held sacred and generally respected; though, in some native wars, graves have been desecrated, and at times "the bones scattered at the grave's mouth," or burned. In their heathen days the weapons of war, agricultural implements, and whatever the deceased used were buried with him, sometimes valuable property also. A warrior's grave would be distinguished by having his weapons placed alongside the tomb.

Embalming of chiefs was practised in olden times. The embalmers were always women of certain families, holding sacredly the function. The operation occupied considerable time. The inner organs and viscera were first removed and buried. The body was then punctured all over with needle-like instruments that the juices might be withdrawn, and scented oils and unguents were repeatedly rubbed into the body. Finally, wads of native cloth, saturated with oil or resinous gums, were placed inside the body, the apertures closed up, and the body wrapped in native cloth, leaving the face, hands, and feet exposed. These are repeatedly re-anointed, with the addition of tumeric powder to the unguents, to give a fresh and life-like appearance to the mummy. It was the function of near relatives to attend to this last operation. The mummy was kept in a house specially set apart for the purpose, and rested on a raised platform, and covered with native cloth.

A singular custom existed with regard to the dead whose bodies had not been recovered for burial, such as were lost at sea or slain in battle. A superstitious dread was connected with respect to the disquieted spirits of such unfortunates. It was supposed that, being unburied by the family, the spirit of such wandered about wretched and forlorn, and would haunt the relatives in their sleep, crying "I am cold! I am cold!" To appease the spirit, the relatives would go out to the sea-shore, or to the battle-field on which their friend was slain, and spread a cloth or fine mat, and sit watching for some reptile or insect, or other creature to crawl on to the mat or cloth, and then they quickly enclosed whatever first came on the article, carried it off, and buried it with some of the usual funeral rites, imagining that the spirit had appeared in

the form of the reptile, &c., and would be quieted by having a "decent burial."

Mourning for the dead was continued for weeks or months, according to the rank of the deceased. At such times the mourners would neglect their persons, wear no ornaments, and clothe themselves in rags or refuse. While the chief lay dead, or the mourners were still assembled, the paths near the spot, and the lagoon in the vicinity were tabu. No one was allowed to pass, and travellers were required to make a *detour* in other directions.

Widows and orphans were respected and generously cared for by their relatives. Sometimes the widow would return to her own relations, or be fetched away by members of her family. Formerly the deceased husband's brother considered it his duty to take the widow to become his wife, although he might be already married. This was done mostly for the purpose of retaining the children and land and property in the husband's family.

In the Loyalty Islands, among the Papuan inhabitants, sickness and death were attributed to the action of evil spirits, often, it was supposed, in consequence of misdeeds, or infractions of tabu, &c. Probably sorcery would be suspected, and then the curser, would be sought out, either to propitiate his anger or to inflict vengeance. When death appeared to be near the friends assembled around the house, the near relations inside, and they united in a chorus of loud screams, wailings, and lamentations, and continued the noise till long after death had taken place.

The funeral arrangements were very simple at Tai (Uvéæ): the sea was the common receptacle of the dead. The corpse was bound to a log of wood or a banana stump, put into the lagoon, and thence floated out to sea: the current generally set seaward to the N.W. The bodies of chiefs and other notabilities were carried by near relatives and deposited in caverns which abounded in these coral islands, or lowered into deep pits in the rocky ground. Many a Petra mausoleum may be found in the sides of the cliffs near the sea shore. Here the bodies were fixed in various postures—some standing against the sides of the cavern, some sitting on the floor, and others were more decently placed on shelves and niches of the caves*. At Wide Bay, on the island of Lifu, there is a large rock near the beach which looks like a Malukoff

* I was anxious to visit a necropolis of the kind at the south of the island, but on finding that the natives were unwilling that I should do so, I gave up the attempt.

tower. This rock is hollow in the centre, with an aperture at the top. A large number of skeletons, more or less dilapidated, may be seen within this enclosure.

Mourning was represented by the natives going naked with their bodies smeared with pipeclay and wood-ashes. This mourning was often continued for a long period. Widows were required to remain in the husband's family; and when any went home to their own tribe, the children were retained as members of the father's family.

Spirit World.

Samoans were great believers in the existence of spirits *(aitu)*, superior and inferior. They viewed the air, the sea, and the bush as inhabited by these beings, some as "wandering about seeking rest and finding none." Certain birds, fishes, and animals were supposed to be representatives and embodiments of these. Men and women at times imagined they were possessed by the *aitu*, and would act and speak as though under demoniacal possession. Persons afflicted with epilepsy were commonly believed to be under the influence of an *aitu*. Consumptives were also supposed to be similarly affected. A near relative of the sick one would arm himself with a spear, and pretend to attack the spirit in order to expel it. In the case of sudden death it was said that an *aitu* had devoured the victim.

There was a Hades, or spirit world, to which the soul was taken soon after death. Samoans had the idea that a death-bed was surrounded by spirits, waiting to bear off the soul immediately on its leaving the body; hence, they were afraid to go abroad at night lest they should be caught by these *aitu* waiting for the dead, and be hurried away in their stead.

The Hades (called the Fafā) was said to be subterranean caverns below the sea, and had its entrance in two circular basins at the far end of Savaii, the western island of the group. One entrance was for the spirits of chiefs, and the other for those of the commonalty. The disembodied spirits of the eastern islands had to travel over these islands to Savaii. At the western end of Upolu there stands a rock called by the natives "the stone of leaping." From this stone the spirits leaped into the sea and swam to the adjacent island of Manono, at the far end of which was another similar stone; from this they leaped and swam to Savaii, then crossed that island to the Fafā, the entrance to which

was through the basins mentioned above. Near this spot stood a cocoa-nut tree, and if the spirit accidentally collided with this tree it proceeded no further, but returned to its vacant body. Natives who had been in a deep syncope or comatose state, and recovered therefrom, were thought to have met with this accident on their way to the Fafā.

These subterranean regions had a heaven, an earth, and a sea, as in the upper world; and the spirits there possessed a corporeal form and engaged in various occupations, as in life, during the day, but at night these bodies were changed into chaotic forms like sparks of fire, and in this state they could re-ascend and visit their former places of abode, but—like Hamlet's ghost—they had to return to their Hades at daybreak. They had power to enter the bodies of their enemies, and even friends, and cause disease and death. They could also hold converse with members of their families, and convey instructions to them in dreams, and could also predict future events.

Within the Fafā there was another region for chiefs and eminent warriors, called Pulotu. Over this region there presided a deity, or king, named Saveasiuleo. He had a corporeal form, viz., the head of a man, and a ponderous body reposing in the temple, the dwelling-place of chiefs, and the extremities, in the shape of a great serpent, spread into the sea. The pillars of the temple of Pulotu were composed of chiefs and warriors.

In the Loyalty Islands, as in some of the New Hebrides, there is no idea of a spirit world other than this mundane sphere. Spirits and demons were supposed to inhabit certain uncanny and weird spots of the land and bush—avoided with awe and dread by the natives,—and were at liberty to wander at night in the roads and gardens near the villages. On this account the natives have a great aversion to leave their houses at night, unless it is moonlight, or there are big fires burning outside. The same word which means a dead man is also used for a spirit. The natives very rarely mention the names of the deceased, from a fear that the spirit of such might be near and be made angry. On many of the New Hebrides widows were strangled that their spirits might accompany those of the husbands. This sutteeism did not exist in the Loyalty Group, yet many widows and mothers immolated themselves with the same design.

When a body was buried, food was for a time taken to the entrance of the cave or hole and placed on stones for the

spirit to come out and regale himself. When such repast was not immediately taken, it was concluded that the spirit was away at a distance. Eventually the food would be eaten—by rats or some other animals—and the friends were satisfied that the spirit was pleased with their attentions.

The Loyalty Islanders possessed ideas of the immortality of the soul, but mixed up with these absurd notions of spiritual existences and transmigrations. They had no conception of a resurrection of the body. Their cannibalism was opposed to the reception of such a doctrine.

Having made this paper so long, although I have by no means exhausted the subjects, I must leave the last two items of the syllabus for a future paper.

5.—SOME NOTES ON THE TANNESE.

By REV. WM. GRAY.

TANNA, so named by Capt. Cook, is an island of the southern New Hebrides. It is about 45 miles in circumference, and contains now not less than 8000 inhabitants. So far as it is known it must have been always one of the most densely populated islands of the group. It is of volcanic origin. There is in it a central range running with the island from S.E. to N.W. nearly, with lower land, but very little plain along the shore. The hills at the south end are probably 3000 feet high, and have the appearance of being the product of volcanoes. Everywhere on the south end and eastern side one finds hills composed of scoriæ, now completely overgrown with vegetation. Here and there streams of lava have been poured out and afterwards covered with scoriæ. But most of the hills seemed to have been raised by such an ejection of pulverised lava, as is now going on at the active crater on Tanna. At the north end of the island the soil seems to be the product of aqueous sediment. Along part of the east coast, round the north end, and down the west coast, the coral reefs have been raised in past ages. On the west coast coral terraces are seen more than 100 feet above sea level. We find nothing of this kind on the eastern side of Tanna. But on the little islet of Aniwa (about 12 miles E.N.E. from the north end of Tanna, and about 15 miles

N.N.E. from the crater) we find the same kind of thing. On the south of Erromanga, an island separated from the north end of Tanna by a strait fully 20 miles wide, six or seven coral terraces may be counted, probably marking successive elevations. These terraces are found about 800 feet above sea level on the south end of Erromanga. The Aniwans have a tradition that Aniwa was connected with the south end of Tanna, and there are traditions of a volcano, probably a mud volcano, on Aniwa. At Port Resolution, so named by Capt. Cook, the harbour has been completely destroyed by successive upheavals on the side next the crater, which is about five miles distant.

With regard to the crater, now about 1100 or 1200 feet high, I need say little. The "lake of fire" seen by the party that visited the crater on June 27th (1890) with Professor Drummond, had entirely disappeared when I visited the crater again on August 8th following. On July 26th there was a severe earthquake shock felt throughout the whole group (and perhaps a day or two earlier throughout the Australian colonies). On August 7th, the day before my visit, there was also a severe shock. When I visited the crater next day, I found that the ledge of ground on which Professor Drummond's party stood to be photographed, and where the professor narrowly escaped a blow from an ejected lump of lava, had fallen right into the crater and had filled up the "lake of fire." But the pent-up fire had forced its way through thousands of tons of stuff and made an active vent. The remaining portion of the ledge showed a suspicious looking rent, making it apparent that another landslip would soon occur.

The inhabitants of Tanna present a type of feature that is distinctly Tannese, but difficult to analyse. Men in their state of nature wear no clothing. All males are circumcised between the age of five and eight. After that ceremony a belt is worn. Part of the ceremony of circumcision consists in teaching the lad how to use his belt. Any string or rattan will do for a belt, but the belt proper is made from the bark of trees and is sometimes ornamented. Males as well as females wear earrings and beads and other ornaments suspended round the neck. Jade is highly prized for this purpose. Youths and men divide the hair of the head, which is generally crisp and curly, into locks about the size of a number 14 wire nail (or an ordinary bodkin). These are served with thin bands of the inner bark of a root much as

a sailor serves a rope, beginning at the root of the lock of hair. As the hair grows, the serving is extended. In a good head of hair, which makes a Tanna man remind one of Assyrian figures, there are 700 or 800 such locks. This practice does not extend beyond Aniwa, Futuna, and Anietyum. Young girls wear a little double apron, made of grass and other material. As the girl grows this apron is enlarged till it becomes the complete skirt of the matron. Certain occupations are the work of females, others of males. The range of articles of food is considerable, but the natives are chiefly non-flesh-eaters. It is mostly on high occasions that they indulge in flesh as an article of diet, fish excepted, which they eat when procurable.

Two dialects of the language spoken on Tanna have been reduced to writing. The Kwamera dialect is spoken on the south end of Tanna by at least 2000 people. It is expected that an edition of the New Testament, through the long labours of Mr. and Mrs. Watt, will be issued in this dialect by the Bible Society of Scotland, about the end of this year, 1891. Other portions of scripture, with hymn book and catechism in that dialect, have been printed by Mr. Watt himself on a small press given to him by the Glasgow Foundry Boys' Religious Society. The Weasisi dialect is spoken by quite as many people on the east coast of Tanna to the north of the volcano. The difference between these two dialect is so great that one native does not understand the other unless they know both dialects. A primer with catechism and hymns, and a portion of John's Gospel, have been printed in the Weasisi dialect. Other portions of scripture are preparing for the press, and a grammar and vocabulary will shortly be in the hands of Melbourne printers. These are to form part of a larger philological work by the Rev. D. Macdonald, of Havannah Harbour. On the north end of Tanna there exists another dialect, but not differing widely from that of Weasisi. On the west coast of Tanna, opposite the Weasisi district, another extensive dialect is met with, that might be described as a cross between the Kwamera and Weasisi dialects, yet having characteristics of it's own. Between this west dialect and the Kwamera dialect there are known to be at least four dialectic variations. The language of Tanna is now taking up many foreign words, chiefly English, which are invariably mispronounced. Strange English words are often used as names, but so corrupted are these one does not readily recognise them.

One hardly expects to discover "dinner" in *Jína*, "spade" in *Súpeka*, "Punch" in *Pinis*, or "snider" in *nairus*.

Tanna is divided into a number of districts, each of which has a name, reminding one of familiar tribal divisions of the Holy Land. The people of these districts are wrongly called tribes. The names of districts, so far as I know, are descriptive of the district to which it is given, or of some feature in it. The people living in such a district are called by the name of the district, whatever the origin of the people. The people here are the Numaragusimini, the people in the district south of us are called the Numakasarumini. *Numa* is about equal to *the open field; gusi* and *kasaru* are the descriptive parts of the above names; *mini* is probably a plural termination. In such a district families are to be found who claim a spot in far distant districts as their native place. Still the people in a district are in a strict sense, and according to native idea, one people, though they have no common chief. In such a district there are smaller divisions indicated by the proximity of villages, or in a still smaller division by the proximity of families. The distinguishing feature of these smaller divisions is the use of a common Imeium, or public square, the ἀγορά of the Greeks, the *forum* of the Romans, the *gate* and *street* of the Old Testament, the *market place* of the New, our own *Assembly* or *Town Hall.* Literally the name means *club-house*, probably from the past custom of keeping clubs there for use or emergencies. There are scores of Imeiums in a single district, many of which are now never or seldom used. At the Imeium, the men generally eat their evening meal; there always they drink their kava unseen by females; there the councils are held and festivals celebrated. Where there is an Imeium for a people, they have a chief.

There are two great divisions of the people which, to a large extent, are geographical. These are known as the *Numrîkwênimin* and the *Kauyameramin.* The people living on the south end and along part of the east coast of Tanna are the Nŭmríkwênnĭmĭn. The Kauyamĕrămĭn occupy the opposite side of Tanna. Kauyamĕră is the name of a very small black bird (possibly a humming bird) with bright scarlet breast and long slender curved beak. It is connected with the myth about Tĕramsămŭs and Matiktíkî. The explanation given of this name in connection with the division of the people is, that the Kauyamĕrămĭn decorate their faces and bodies with red paint. The Nŭmríkwên are not

supposed to use red paint for this purpose. The termination *mera* means blood or bloody. *Kau* is a root found in the names of other birds, as *kanyamît*, "the owl." I have been able to get no explanation of *Numrikwên*. I should say that in times of peace Kauyamĕră people are found living among the Nŭmrîkwên. But all are afraid to go into one another's districts unless there are friends whose protection can be claimed.

There is still another division which takes no account of districts or the division just given. The people living on the coast all round the island are *Kwatahrenimin* those inland are the *Nîĕlî Asolîmin*, the people who make big feasts, or *Numatakeiyiv*. These are undoubtedly names of division, like our *rustic*. The exact meaning of Kwătăhrĕn I do not know, but the idea it expresses when applied by the inland people to the littoral inhabitants is, "those fellows down below." *Nîĕlî Asolîmin* get their name from the high price they set on their things. For a very small yam they expect a large pig. All their sprats are mackerel in fact. The meaning of *Numatakeiyiv* I do not know, except that it is one of derision. A similar term to the above in pigeon English is "man bush." Hence, a person who does a thing in awkward manner is a "man bush."

These divisions are of importance in matters of war. The Kwătăhrĕn and Nŭmatakeiyĭv are divisions that do not count in war. The others all do. War may exist between two villages in the same district, or between the people of one district and that of another district, or the people of several districts may be united in carrying on war against a single district or several united districts. Still these are all called *small wars*, and the indignities of cannibalism are not perpetrated on the fallen foe. But a war between the Nŭmrîkwên and the Kauyamĕră is a great war, the Crimea of the Tannese. Then cannibalism is practised. One district of the Nŭmrîkwên may be at war with another district of the Nŭmrîkwên, yet both would carry on war against the Kauyamĕră. In all wars it is life for life. But in the great war it is any man of the Kauyamĕră for one killed in the Nŭmrîkwên. If a man at the south end of the Kauyamĕră region kills a Nŭmrîkwên the life of a man at the north end will do to pay for him.

The instruments of war were various kinds of heavy clubs, spears, the kanivah (the handstone of the Greeks), and bows and arrows. Now these are all supplanted by the white

man's musket of infinite variety of pattern and age, from the flint lock to the Tower V.R. Snider. Some of these guns that have come into my hands are almost as old as the century, some of them are newest patterns made specially for our island traders to sell at a large profit, and that collapse before the native dupe has finished proving the superiority of his new and hard-earned treasure. In the old pre-musket days there were well recognised war tactics; now there is but the one tactic of "pot-shooting."

It is at least a careless way of speaking to say that a Tanna man is never happy except when fighting. That is just the time when he is not happy. Rumour of war fills the Tannese with unspeakable dread. The great wars are now practically a thing of the past, and even the small wars are diminishing. Mission influence is such that a missionary can persuade his people to make peace. The Tannese themselves, who really hate war, recognise the benefit of peace.

We come now to the religion of "Man Tanna." One might visit every conceivable place on Tanna and not see stone or stock that he would take to be an idol. Nor would he see a temple of any kind nor hear a prayer. Are Tannese then without a religion? No. The Athenians in Paul's day were not more religious than our Tannese now. There is no act of life that is not some way religious, from the birth to the burial. But you must know Tannese in order to get an idea of their religion.

Tannese have nothing that can rightly be called *idols*. They have stones that some call idols. But our idea of an idol is definite. The so-called *idol stones* of the Tannese *contain* spirits. It is these spirits, not the stones, that are served.

But to get an idea of what a Tanna man's religion is we must state the underlying principles of his faith. These are:—

1. Belief in the immortality of the human soul. Death ends a great deal, but it does not end all. The spirits of the dead hold intercourse with their friends on earth. A man makes a house in his plantation, large enough to shelter a cat, puts food there broken small, and asks his departed father to come and make the things in his plantation to grow well. A person does not dread the spirit of his friend, but he does fear the spirit of an enemy.

2. Belief in Hades, called Ipwai. The entrance to it is in the north end of Tanna in a cave. The spirits of the dead go there, when is not certain. It is a sort of fairy land not unlike this life.

3. Belief in one supreme divinity called *Uhgen*. It is not however certain that Uhgen is a *being*. *It* is clearly the supernatural power that is behind all things. A watch, a gun lock, even a stone wall that a missionary will build, is *nadî man Uhgen*, a thing made by God. The native mind does not think of more than *one* Uhgen. But Uhgen comprehends the great supernatural power or powers for that matter, conceived of as a unity, behind all things, and is benevolent. But beyond that the native mind has not reasoned out what his character is.

4. Belief that Uhgen *has spoken to man*. This is the key to the understanding of a Tanna man's religion. Ask about any natural feature, the answer is "Uhgen put it there." Ask who gave names to the Imaiums, "Uhgen did." Ask about the origin of any custom, "Uhgen gave it to our forefathers long ago." Above all; where do Tannese get their sacred stones? The answer is, "Uhgen gave them to our forefathers long ago." But ask who makes bread-fruit, fish, yams, rain, wind, sunshine, the answer is, "Such and such a man." How does he do it? "Uhgen gave this power to certain of our ancestors long ago." In short, Ughen made the world and committed, what we call *Providence*, to certain men. On the caprice of these, their fellow men must depend. It is these fellows that do all the mischief in human life.

5. We come now to consider the *tools* by means of which these men, to whom the Providence of the world is committed, execute their trust. The outward forms of these tools are the "stone idols" for the most part. These are called *nauvetîmin* literally, perhaps, the *lumps*. The Tannese have "lumps" for doing everything in the whole universe of heaven and earth. There are some supernatural powers possessed by the Tannese which do not require the aid of "lumps." It was Uhgen that showed the ancients how to do these things. This knowledge is strictly a revelation from Uhgen. This knowledge consists of:—

(1.) Things that are Talismanic. There are certain stones handled or carried about the person when engaged in war. This will bring the enemy within range. There is a process of capturing a butterfly which is an indication that the person is to go to war and will be victorious. A small piece of wood carried on the person will render him invisible to others while he can see them. And so on *ad infinitum*.

(2.) Tŭbahans, what is now known as taboo. These are without number, and most useful amongst a people who have

no courts of justice. The rule is, steal whatever you can without it being found out. But a tŭbahan is a more effective barrier to petty thieving than the penalties of any police courts. "Tŭbahans" are generally used to prevent cocoa-nuts being taken (by stealth or) before a certain time. And so with other things. The process is more or less this. Some reeds are cut close to the root. The leaves are pinched off. A certain leaf, known to the "tŭbahaner," is taken and the prepared reeds rubbed with it. Some of the leaf so used is put in a cocoa-nut shell and buried in the ground. Around this spot some of the dressed reeds are set up stuck in the earth, the tops tied together, and one cocoa-nut or more suspended from the tie. This is called the root of the tŭbahan. The rest of the reeds are taken away to be used. These are stuck in the earth wherever wanted. To every such tŭbahan a penalty is attached, and no man will touch a thing so tabooed.

The penalties, self-inflicted, vary with the "tŭbahan." The penalty may be wasting of a person's limb or of the whole body, boils, ulcers, ringworm, sore eyes, plagues of gnats, flies, lice, toothache, pains and aches of all kinds—in short, all the ills that flesh is heir to. The person who can make a "tŭbahan" can also cure its evil, should another happen in some way to transgress a "tŭbahan." He can cure either his own "tŭbahan" or the same "tŭbahan" set by another person. If, the natives say, a "tŭbahan" sickness be neglected, it will result in death. But what is usually done is this—if a person has something wrong with him, a "tŭbahaner" is consulted; if he tries to remove the evil and fails, the conclusion is that it is some other "tŭbahan." A succession of "tŭbahaners" may try and fail. Then the conclusion is that it must be some foreign disease that no one knows how to cure. If the sickness goes on, and death ensues, the conclusion is that it was Nŭrŭk, of which we will speak presently. The points to notice are these:—(1) "Tŭbahans" are the vehicles through which spirits work. (2) No disease is therefore regarded as having a physical cause. Though remedies are used they are used to expel or appease the spirit causing the sickness or pain. (3) The penalties for transgressing "tŭbahans" are all minor diseases. I must add now, what I should have said earlier, "Lumps" are sometimes used in making "tŭbahans," but they are mostly made without.

(3.) *Nauvetî nadî* is a general term for the stones used in

producing influence in nature. But there are special stones for doing particular things. *Nauvetí nuh* for making yam; and special kinds of yams have their own stones. So with wind, rain, sunshine, fish, turtle, and all kinds of natural produce. The ceremonies connected with these probably vary; what they are we know very little. Space will not permit us giving an instance of which we learned something of their use.

(4.) *Nauvetí Nuruk* is the prince of "lumps," for it contains the power of life and death. Recently a set of Nŭrŭk stones were dug up by a trader here, and given to me. The large stone is called the body of the Nŭrŭk. It resembles a man sitting with his head drooping over his chest, just as a weary sick man would sit. Its length is 8 in., and measures about 11 in. in circumference. It weighs 4 lbs. It is a black recent-volcanic stone of irregular structure. Some parts being dense, others almost scoriaceous, and embracing little black nodules of denser grain. The little stones are called the *children* of the big stone. 4 is a black stone of fairly close texture, 2 in. long, 1½ in. high, and 1 in. wide, and sufficiently like a person's foot to be spoken of as *the foot.* 5 and 6 are almost alike, 2 in. long, nearly 3 in. in circumference, and are recognised as representing members of the human body. 7 is a hard black stone, 1½ in. long, thicker at one end than the other, and is thought to represent the knee end of the human *femur.* The four little stones are minor Nŭrŭks, capable of producing continued indisposition, but not death. So much for the Nauvĕtî Nŭrŭk; now for their use and power.

I must say here that those stones are all the habitats of spirits (I speak now after the manner of Tannese), and they are in the possession of certain persons who are termed *yolnuruk*, a nŭrŭker. But he has no power over any one until some thing that has touched or come from the body of that person is brought to him. For this purpose the part of a man's food, his belt or garment, can be used. In fact a stick he has had in his hand, a stone on which he has sat may be scraped, and the scrapings taken to burn as Nŭrŭk. An unused part of a stick of tobacco is a common thing to take. This is called *taking the foot of a person.*

Once taken there are regular Nŭrŭk carriers, who, while they are carrying *the foot*, will never cross fresh water. That would render *the foot* useless. Hence, if a thing can be washed, it is proof against Nŭrŭk. The first Nŭrŭk

carrier passes *the foot* on from carrier to carrier so that the original taker may not be known. In this way it may be carried far afield. And to make sure that the person's death be accomplished, the thing taken may be divided, one part given to one "yŏlnŭrŭk" and one to another.

There is some obscurity about the meaning of the term. In this dialect *numa nuruk* is a dead leaf fallen from a tree. In Kwamera dialect the word is *nahak*. In the west dialect it is *netuk*. *Tisei* is the term used of the "nŭrŭker" putting the thing in the fire. *Teserik itami* is to burn a person's nuruk. And the word for a scorpion is *yeserik*. These words are evidently from two roots, *es* and *erik*. That *erik* and *nelhki* (foot) are from the same root may be fairly assumed. Yet the form may be accidental; hence, *teles nelhki tami* may not mean "he takes a person's foot," but, "he takes a person's nŭrŭk." The scorpion's tail is like a nŭrŭk when ready for burning. The word nŭrŭk in some of its meanings might be translated *refuse*.

When the "refuse" is put into the hands of the "nŭrŭker" he is told whose it is, and instructions are given to him as to the length of illness wished. He now takes certain leaves, known to him only, and breaks these very small, and in the same way the *refuse*. Then all are thoroughly mixed, as cookery books tell us. The Nŭrŭk stone is now rubbed with this and transferred to a basket just above the fire. The prepared "refuse" is put in leaves and tied in shape like a rolly-poly pudding. The length depends on the duration of the sickness. One end is put in the fire and the "nŭrŭker" watches it day and night. If it is burning too quickly, he withdraws it. He may even take it out for a day or two to give his victim respite or time to go and search for his Nŭrŭk; for when the Nŭrŭk is not burning he may recover somewhat. The instant the Nŭrŭk is all consumed, the victim's sickness proves fatal.

The object of taking a person's Nŭrŭk varies. A Nŭrŭk-burner may covet the pig or gun of another man. He gets his "refuse" taken, and then takes care that his victim shall know it. The price of taking the Nŭrŭk out of the fire is the coveted article, which is given. Some one may simply wish to torment a man, and he takes his Nŭrŭk. In other cases a victim's death is desired; then it is not easy to trace the Nŭrŭk. For weeks the matter may be talked about and no end of stuff paid to trace the Nŭrŭk. When traced sometimes the Nŭrŭk is brought back to the victim, but

generally the Nŭrŭker's word is taken. He says what the "refuse" was, and the victim is able to remember where it could have been got; and so water is poured on the fire and the victim recovers. A Nŭrŭk stone may produce any form of fatal disease, rarely, if ever, a single disease.

It is unusual to assume that everything connected with Nŭrŭk is a disception. Nothing can be farther from the truth. The Nŭrŭker believes in his own power, and so their people. There is no scepticism amongst Tannese on any religious matter: scepticism is a parasite of the Gospel. A Tannese never thinks of deception being practised in these matters. If a Nŭrŭker says a man's Nŭrŭk has been taken, he is able to present satisfactory evidence of its truth. Indeed deception is not possible. If a man said he had taken someone's Nŭrŭk when he had not done so, purely with hope of getting pay, he could no more keep the secret to himself than our proverbial woman. To tell another would be to tell the man himself.

The coincidence between the burning of Nŭrŭk and the state of the victim is astonishing. A man's Nŭrŭk is taken and he falls ill; it is recovered, and he recovers. A man falls ill without knowing that his Nŭrŭk has been taken; search is made for it; when found he recovers. So constant is this that no native mind can resist the conclusion of their being a direct and objective connection. And even men with minds better trained than the unsophisticated native mind have been unable to resist drawing the inference the natives draw. Good intelligent christians accept evidence of direct answers to prayer less satisfactory and conclusive than that presented in cases of Nŭrŭk. One has to approach such evidence in an immovable belief that there is no such connection between the victim and his Nŭrŭk before he can reject the evidence that there is such a connection. I do not affirm that there is such a connection, but I do maintain that we must have something more satisfactory than the stock explanations of mental reflex action and imposture. Reflex action through the mind there is; imposture I am well convinced there is not.

Every Nŭrŭk stone has a name. One is known as Kăsămkăseivía, other Kălăplabĕn (night or blackness), Tagirakau (said to be a very powerful one, and one that "peeps" when separated from its little stones), Nŭmanúlilúhúasúl, and Kúsăsiva. The name of my Nŭrŭk stones has not been recovered. These stones are not at present in

the hands of a class, but every Nŭrŭker is a chief, because he is a Nŭrŭker. He may also be a governing chief. These supernatural powers are widely distributed. One man is a Nŭrŭker, another makes rain, another fish, and so on. Women sometimes are "tŭbahaners." The knowledge of these things is handed down from father to son. The owner of the Nŭrŭk stones now in my possession died suddenly, without a successor; hence, it was not known where they were buried, till unearthed accidentally, and hence, the loss of the name at present. Natives to whom I have shown these stones shudder with terror at beholding them. All Nŭrŭk stones are not equally powerful. There is uncertainty in the native mind as to the sex of these Nŭrŭk stones, or rather the indwelling spirits. Natives are of the opinion that they are male gender. Yet they feel that there must be something of the female about them. They bring forth Nŭrŭk stones. The terms used to describe the burning of the Nŭrŭk suggest that the stones or spirits are feminine. But I suspect that the idea of sex does not apply to superhuman beings. They are not limited as human beings are. A monster that can fish up a great island out of the sea can weather a storm, in which sky and sea are mingled, in a frail bamboo canoe a few inches long. So it is with sex as applied to superhuman beings. To the belief in these we now turn.

(5.) Belief in superhuman beings. It is common to speak of these as gods. To my thinking this is a mistake and altogether misleading: they are human monsters possessing superhuman attributes. They are the Noahs and Samsons of the Bible run to unlimited extravagance. They are the heroes of Homer and Virgil. Diomede is said to have

> " . . . . Seized in his grasp a hand-stone
> A huge affair, which no two men could carry,
> Such at least as mortals are now . . . . . "
>
> —*Il. v.* 302.

This exactly describes the feats of these ancient "heroes" of our Tannese. These "heroes" are not all of equal importance. Some of them are quite local such as Nupúa, the ancestor of the Numanagusimini, and Doligia the ancestor of the Numakasarumini. Others again are not so local; such as Karapanŭmei, who is known on Aneityum as Inhujeraig. Still less local is Matikítkî, known on Aneityum, Tutuna, and Aniwa. Indeed he is a character known throughout the Pacific. We give below a tradition of Matikítkî's feats set over against a local hero of Tanna, Tĕramsămŭs. It is

doubtful if the Tannese ever paid worship to these beings. They certainly do not do so now.

The story of Tĕramsămŭs and Matiktíkî is given in the Kwamera dialect, and taken down by Mrs. Watt from the mouths of natives, who spend hours in the evenings reciting such stories as these, which they there call *kwanangei.* The following is a fairly literal translation for which I am responsible. I should observe that the present tense is used as an historic past:—

"Tĕramsămŭs, having eaten all the inhabitants, goes and looks for black people, eats them, then looks for white people (this does not mean Europeans) and takes them and throws them into a hole of a rock and shuts them up, and says to them, that they are to wait for him till he goes and makes *nikasî nerî* for their food. They remained in the cave and sang and danced.

"Matiktíkî goes past and knows that he hears dancing. He says, 'Ho! Who are you?' They dance, but say, 'We here.' But he says, 'You are who?' But they say, 'We here, our ancestor goes to make *nikasî nerî* for our food.' But he says, 'They say he goes to make *nikasî nerî* for your food, whereas he kills you and goes to make *niparara* with you.' [Note: they in the cave understood Tĕramsămŭs had gone to get taro (nerî) to prepare us food for them. Tĕramsămŭs intended they should so understand him, but his real intention was to get taro to cook *along* with them to take up the flavour of the meat, just as we cook Yorkshire pudding]. But one says, 'Alas my father-in-law!' But another says, 'Alas my father!' Matiktíkî stands and holds a *fufau* (a white stone axe used for cutting out canoes) and breaks in pieces the rock (?). They came out and, going up, ran until they came to a place and saw a row of fish shorewards. They ate and leave none of Tĕrámsămŭs food.

"Tĕramsămŭs ran and ran and cleans *nikasî nerî* and goes back to the hole of the rock and sees they are gone. But says, ' . . . (bad language). I have spoilt all my food!' He runs and runs holding his head down westward and feels it cold; he runs eastward till he feels it hot; he runs and eats his fish.

"Matiktíkî and the children (the fellows out of the cave) run and feel they are tired (?) and look up and see a *makopo*, (a variety of breadfruit) hanging. They go up and pull out its core and the children go in and fill up the space (a hole six inches long and one and half inch diameter). Matiktíkî

sits on the edge of the cave hole and puts in again the core.

"Těramsămŭs runs and runs and feels hunger biting him greatly and looks up at that *makopo* and sees it hanging, says, 'Let me pluck the *makopo* and cook and eat it and be satisfied and search for my food' (the people who had escaped from the cave). He goes and takes wood and heaps it together and climbs and plucks the *makopo* and comes down and lays on the fire and cooks it. The youngsters feel the steam, which is killing them. Matiktîkî says (telling them what to do. The youngsters do his bidding) and the fire goes out. Těramsămŭs takes away the breadfruit and lays it down and goes and looks again for wood. They pull out the core and come out and put the core in again and run and run and look up at a she-oak tree and see it standing inland they run inland (?). Matiktíkî says, 'Hasten for the she-oak.' They hasten and hasten and come just there below. Climbing up it they go all to the top. Matiktíkî has already seated himself in the fork of the tree.

"Těramsămŭs looks for them, and was going hither and thither, and goes up and looks down into a pool of water. Matiktîkî tosses frequently his crest of feathers. Těramsămŭs (seeing Matiktíkî reflected in the pool) springs down and splashes in the water-hole and comes up and was standing. Matiktîkî says, 'Youngsters! laugh.' The youngsters laugh and say, 'Hoe! What are you doing there after having ran hither and thither?' He says, 'Alas! My children. How do they make it to go there?' They say, 'We went on the palms of our hands.' He goes there on his hands and splits them, and says 'Alas I have split and spoilt my hands. How do you always do it?' They say, 'We went on the soles of our feet.' (The same thing befel his feet, his head, and his knees). Matiktîkî says, 'We went on this thing,' and lets down a small rope to which he hangs on and goes up and cannot make the fork of the tree, says, 'Alas my food! You do tease me.' Matiktîkî takes a *fufau* and cuts in two the small rope, and he falls down and strikes on the ground.

"They send forth a black dove; it goes and shouts into his ear, and finds that he lies and is silent. They send a bronze-wing dove, and it wails and finds that he lies and is silent. They send a *míahî* (an ant whose bite is very painful); it bites him and sees that he lies and is silent. They send a kauyameta (see divisions of Tanna; a small black bird

whose red breast is thus accounted for); it goes and stoops and passes right through the body. They see blood stains on it. They exclaim, 'He is dead verily!' They come down and go and behold. Matiktíki takes a bamboo fishing-rod (from which he makes a knife) that he may lance the body. One by one they rise till every one who had been eaten all came to life."

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1. *Circumcision.*—This is performed on boys after they are five years of age, but generally before the boy reaches his teens. The boy must be old enough to be easily controlled, but if it has not been circumcised early, no age would exempt him. So universal is the rite that no male escapes circumcision. I do not know of any legend as to the origin on Tanna. The objects in view are various. It is thought to make a man fruitful. It makes the boy a real Tannaman, and a man in the same sense as Latin *vir*. Only certain persons can perform the rite. A man who can circumcise may have to be brought from a considerable distance. A temporary house is made in some secluded spot near the sea, preferably for the sake of the bathing. A single boy may be done, but generally boys are kept until several can be done at one time, generally about March. The operator holds the penis with a leaf of grass put round the glans, the foreskin is divided on top lengthwise. The foreskin is then cut down each side of penis so as to leave a wing of skin each side. This appears to be gathered under the penis, where, after it is healed, it forms a lump nearly as large as the gland of the penis. The larger the operation, the more of a man does it make the boy. There is a small feast when this is done, and the boys are kept in an enclosure. The details vary during this confinement. The men of the village keep about the place, but two or three virgin youths are told off to attend to the boys. Their food is prepared by a virgin girl. The boys get flesh of no kind during their confinement. The food is eaten by the boys in perfect silence. If a boy were to speak, then his food would be taken from him and thrown away. I have seen the boys feeding in separate stalls. The boys are taught to put on the belt and tie up the penis. Strips of cloth, or leaves, or grass even, are taken and made into a bundle about as thick as a boy's wrist and about eight inches long. That is, the strips of cloth are laid side

by side. A cord, generally made of cocoa-nut fibre, is used to bind these together. Beginning at one end—the top—the cord is wound round the bundle of strips of cloth. When about half wound the penis is inserted in the free end of the bundle, and the winding completed. The belt is then put on so as to hold the whole against the lower part of the belly. To void urine, and to bathe, this bundle has to be untied (about half way) and taken off. When once these ceremonies are over, it would be a shame and disgrace to let anyone see the penis. The boys are kept in confinement till the penis completely heals, which it generally does in about a month; at least that is the normal length of confinement. If the wound does not heal, as sometimes happens, there is a farther detention; when once healed the boy is ready to come out. But should it happen, through bad weather or anything else, that the things desired for the final feast cannot be got, the boys will be kept in until these can be got. There is a feast when they are brought out. If the father or guardian of a boy is so minded he can make the feast a very important one. I have had the exceptional opportunity of examining two subjects. Circumcision as here practised is no safeguard against disease. The knob below the penis is of service for suspending it with the belt, but it must be more or less an obstacle in cohition. I should mention that the boys are taken out of the enclosure daily to bathe in the sea. While this is being done conchs are blown to warn off females, who must not see these boys at this time; and, generally the night before the final feast, the blowing of conchs is kept up nearly the whole night. There is no single term for circumcision in our dialect of Tanna. Kŏs nĭtŭm (nĭtŭm is name of penis wrapper), "one takes the nĭtŭm," is a common expression; others are—kahngîpĕn tatamĕhlî noa manpanga, "shut up to lie within the manpanga;" tawal, "he feeds on pudding,"—probably having reference to the mode of cooking the food for the boys. On Aneityum, Futuna, and Aniwa the practice was the same as now on Tanna; but on Eoromanga the practice differs. There the rite is delayed till manhood is reached. Then it is a matter of individual choice, an exhibition of heroism, and a challenge of purity.

An operation is performed on girls when very young, but its exact nature I do not know. It is supposed to make coition, easier and in the case of common prostitution, where a woman must receive scores in a day, it is supposed to make coition tolerable.

2. *Kava.*—The plant, so far as I know, is the one well known. Only the root part is used. I have seen a kava root—that is, the whole bunch plucked up—which would be a good lift for four men. It is an article of great value here. About an hour before sunset preparations are made to get the kava ready. The root of kava is divided into pieces about the size of a large mutton chop. Each man takes a piece and carefully brushes off all earth sticking to the root; then each man chews his share until it is completely saturated with saliva, and the fibres severed. This is put into a small wooden trough. A virgin boy (the hands of a married man are regarded as perpetually unclean, and no female must see a man drinking his kava) pours water over the mass, and mixes all with his hand, squeezing it through his fingers for a time. Then he dips into the liquid a bunch of fibre such as is used for making cordage. This soaks up the liquid, which is wrung into a cup made with fresh banana leaf. This cup is made by gathering the sides into both hands just as one would make a pouch with a handkerchief. As there are still some fibres in the liquid, these are got rid of by drinking it through a tube, made of the new unrolled banana leaf, just as boys drink through a straw. A person drinks about two cupfuls (20 oz.) at a time. The first washing of the *marc* in one trough will give three such drinks. Water is again added and enough made for three more men. When this liquid is exhausted, the dry powdery *marc* is thrown out, the trough put in the house, and the bundle of fibre hung up to dry. Each individual, when drinking, stands a little apart and yells. Each man has his own peculiar shout. A chief here has taken to imitating the whistle of the A.U.S.N. Company's steamer "Truganini." Then each man sits down to eat his evening meal. The Tannese like to drink their kava just as the sun sinks out of sight. After the kava has been drunk, all conversation ceases on the part of the drinkers. Those who have not taken any, speak to one another in whispers and laugh, often at the antics of the "drunks," under their breath. Women are excluded from the public square. The pungent taste and stringent effect of the kava cause incessant spitting for the first hour after drinking it. A man will sit on a log with a large pudding in his hand, staring into vacancy, slowly striving to eat an enormous mouthful of food. He will give two chews and then pause, much as a horse will cease eating to listen. Then he goes at it again—two chews and a pause. At last the whole goes down with a gulp, and

he expectorates straight out with a vengeance that would beat the proverbial Yankee hollow. The expectorating is done with a whish peculiarly its own. The effect on an onlooker is peculiar. A still evening settling into the gloom of night; half a dozen privileged youths bursting with fun; a dozen or more men sitting round a fire looking at one another without seeing one another; the gulp of deglutition and the whish of expectoration that seems to come in between the chirps of innumerable crickets. In the midst of one such scene a violent earthquake made the earth heave and the trees sway to and fro.

The effect on individuals depends on the quality of the kava root, the strength and quantity of the potion, and the idiosyncrasies of the individual. Chewing the root paralyses the sense of taste and feeling in the tongue. If the dose has been sufficient (I speak from observation and enquiry—my experience has never extended beyond chewing a bit of small root), the eyes soon become affected and things go round, as natives say. The speech becomes slow and thick; the legs are partly paralysed; the gait is irregular, very much like the steps of a landsman newly on board a ship pitching in a heavy sea. The effect lasts for some hours, but gradually subsides. The power of kava can be very much increased by the addition of leaves, flowers, &c. of other plants. An almost powerless draught of kava can be so intensified to produce something equivalent to the delirium of our "drunks." When a man has "got 'em badly," he has to be thrashed into his senses, and has for days thereafter a violent headache. I once had to do with an English trader who was thus drugged. He had been boasting that the kava had no effect on him. So the natives added the leaf of a plant imported to Tanna, and then gathered to see the "fun." The man nearly tore the house down and saw "snakes" all night. It took him several days to recover. The flower of the rose apple is also used in kava to intensify its effects, and there are other plants so used.

So far as I can gather, the use of kava never produces an effect similar to the craving for drink. No man would ever think of touching kava till the evening hour. Anyone can give up its use at will. The drinking of it is a sort of sentiment—a thing a good Tannaman ought to do. Natives have compared it to our use of tea, and have said they feel weak without, and strong with, kava. There are doubtless religious beliefs connected with its use. Perhaps they have

the idea that drinking kava protects them from the influence of evil during the darkness. I have not yet found traditions of its introduction to Tanna. In any case that must have taken place long since. The use of kava is referred to in ancient folk-lore and songs.

3. *War.*—I wish to revise my reference to war in another part of this paper. What is stated there was true at the time that it was written; but later experience has taught me a few things that did not present themselves to me before:—(1) There is, I believe, a necessity for war in the conditions of the life of these people. Human nature is just human nature, and wrongs must arise. Indeed, it is not the sense of right and justice, but fear and sentiment, that keep down wrong. And when wrongs do arise, as they must, how are they to be adjusted? War is the only thing that can adjust them by satisfying the public conscience. Compare David's legacy to Solomon, 1 Kings, ii. 5-9. (2) The victory depends almost wholly on the falling of chiefs. Recently a chief was shot, and in 24 hours after hundreds of people fled from their homes, and chief after chief went over to the enemies of the people of the fallen chief, on whose (the chief's) side they had been till he was shot. (3) In such a case the separating of the people is absolute. There is no longer any hesitation as to the side on which a man is. If there was any doubt such a man would be driven out or killed. (4) When things have come to this pass war is beyond the control of everyone, and must be fought out. This sometimes happens among civilised peoples. Cannibalism is then practised on a fallen foe, should he come into the hands of those who wounded or killed him. There are various ways of heaping indignity on a fallen foe. One is to dig up his corpse and give it to dogs and swine. Another is to mutilate the dead—sometimes those who are not dead. But the greatest of all indignities is to eat your enemy. But I suspect there is a limit as well as a significance in eating human flesh. From what I have just heard I suspect that females are forbidden this. More, it is only eaten by certain chiefs, whose is this privilege, in the same manner as turtle can be eaten only by certain persons. But there is probably the belief that eating a piece of your foe confers strength on the eater. In relation to cannibalism it must be remembered that these natives are not troubled with our fine feelings about food. In this respect they compare with Chinese,

4. *Uhngen.*—I am not in a position to supplement greatly what I said on this head. The word, so far as I know, may be said to have been taken entirely out of common use, but it has a tendency to come back in a roundabout way. The word ûhngĕn ("kûmêsĕn" in *Kw. dialect*; "ûhngĕn," *west dial.*; "sûpweê" or "sûpê," *Efati to south end of Epi*; "Nôhbû," (?) *Erromanga*; "Tatapûa," *part of Emai, Aniwa, and Futuna*; "Nethuing," *Aneityum*) is no longer a simple adjective or verb, and in all its common uses it has now behind it the superhuman idea. Natives will say of certain things, Uhngen ticinol, "Uhngen made it." But doubtless the word had first of all a common use, as much as our God had, which made it suitable as a description for a thing that is superhuman. This is shown now in that the word with its superhuman meaning is taken to express a common thing. Thus a mole or wine-mark on the body is uhngen (noun). A stain on the floor that cannot be washed out is uhngen (noun). A window fixed so as not to open is said to be kol uhngen—"one made it uhngen." There is also an undefined idea that a person after death will be made uhngen* (I cannot say *an* uhngen, because such is the native mind that a thing may be one of a lot and still the whole lot). Sometimes uhngen is applied to complicated mechanism, as a watch or gun-lock. I used to think that this was because of its being something superhuman, but it may signify nothing more than that such a thing is hard to undo. These uses point to fixity, eternity (past and future) and perhaps superhumanity, as root meaning. I do not hold that "Tatapûa" is the same word as uhngen, yet it may be. Natives, I think, take them to mean the same thing. Nor do I hold that "Nôhbû" is the same. I have doubts as to its meaning being the same. "Nethuing" is given by the early missionaries on Aneityum a meaning different to the above, but the natives identify the two. I have no doubt about "Supive" both as to etymology and meaning.

5. *A Correction for p.* 17 *of MS.*—Instead of "Nŭrŭker he is told whose it is, and is instructed" &c., read "he is *not* told whose it is, *but* instructions" &c.

6. *A Native Song in Kwamera Dialect.*—It was first collected by Mrs. Watt and then sung over to me. The words in v. 1 are, so far as the Tannese know, without

* This is the meaning Dr. Gunn puts on Tatapûa.

meaning. They are sung first to give the tune, and may be repeated before any verse. The tune resembles that in Bateman's Hymn Book for "Come to Jesus just now." The song is not more than four years old. The subject is the shooting of Yĕhtû (called Yĕrû in the song) by Pûsî. The song is in the Kwamera dialect, but Yĕrû was a man speaking the Weasisi dialect. Hence there is an attempt to use some Weasisi words.

1.	1.
Ua rên rên raô	These words have no meaning
Ua rên rên raô	so far as we know.
Ua rên rên raô	
Ua rên raô	
Rên rên rĭnraô	
2.	2.
"Awê! Nûĭt keikei!	"Oh, beloved Niut[1]
Awê! Nûĭt keikei!	"
Awê! Nîŭt keikei!	"
Irîpen îau	Lead me there
Yakatĕrĕng paison."	That I may feel the poison.[2]
3.	3.
In kŭrî rĭneivî;	The evil spirit prompted
In kŭrî rĭneivî;	"
In kŭrî rĭneivî,	"
Ravahî meven;	He takes (it) and goes.
Rŭmaha ravohêraka	Rumaha takes (it) away.
4.	4.
Pŭpŭm tĭ-ratîûta;	By and by he will ascend[4]
Pŭpŭm tĭ-ratîûta;	"
Pŭpŭm tĭ-ratîûta—	"
Rĭnahtî[3] Yĕrŭ,	He has shot at yeru
Mahtî nûprei nirŭs.	And shot the trunk of a nirus.[5]
5.	5.
"Awe! kaha Pûsî;	"Aha! my grandfather Pusi;
Awe! kaha Pûsî;	"
Awe! kaha Pûsî—	"
Rĭnarukê[3] Yĕrû,	He has shot Yeru
Mûranî neirŭs."	And shoulders his snider.

6.

" Awê nĭma ûnak!
Awê nĭma ûnak!
Awê nĭma ûnak!
Yĭma afwê Pûsî
Rarûkí[7] îau."

6.

" Oh, my kindred!
„
„
That fellow Pusi
Has shot me!"

7.

Yĕrû ramasŭk—
Yĕrû ramasŭk—
Yĕrû ramasŭk :—
Makwein abŏmŏs :—
Awê, nŭrŭk Nŭpau!"

7.

Yĕrû keeps crying :—
„
„
And calls long :—
" Oh, my child Nupau!"

8.

" Awê, nŭrŭk Nŭpau!
Awê, nŭrŭk Nŭpau!
Awê, nŭrŭk Nŭpau!
Nŭrŭk Nŭpau!"
" Awê, Tata Yeru!"

8.

" Oh, my child Nŭpau!
„
„
" My child Nupau!"
" Oh, my father[8] Yeru."

9.

Kahû ramasŭk,
Kahû ramasŭk,
Kahû ramasŭk,
Makwein abŏmŏs :—
" Awê mĭrâk Yeru!"

9.

Kahu keeps crying,
„
„
And calls long :—
" Oh, my father-in-law Yeru!"

10.

" Awê,[9] nĭma îmak!
Awê, nĭma îmak!
Awê, nĭma îmak!
Tî-arîêr
Mata nokweikwei."

10.

" Oh, my kindred!
„
„
Stand you three there
And look at the raw flesh
(of the wound)."

11.

" Awê, yakĭnamapau!
Awê, yakĭnamapau!
Awê, yakĭnamapau!
Nĭma îmak tî-o
Mŭvhî îau."

11.

" Alas, I have become weak
„
„
My kindred do ye (something)
And take me."

Notes on the song. [1]*Niut* is probably the spirit of a dead person supposed to give help to his descendents when a bowl of kava has been set out for the spirit to drink. [2]*Paison* is our word poison. [3]*Renahtî* is a mixture of two dialects. The part *ahtî* is the word in Weasisi for "strike" or shoot, but *rin* (instead of tĭcĭn (c=g in gate)) is the preformative in Kwamera dialect. In the next verse *rinarûkî* is used, which is the verb and preformative, both of the Kwamèra dialect. [4]*Yeru* was shot on rising ground and carried to a friendly village where he was afterwards buried. [5]*Nîrus* is a tree, the bark of which is poisonous, and would prove fatal if allowed to touch one's skin. [6]*Neirus* is a corruption of our word *snider*. [7]Present tense is used to describe a thing that is past. [8]Nupau and his wife Kahu have arrived. These are his words in answer to Yeru. [9]Yeru speaks. Although sung in this order, I suspect that v. 10 should follow v. 11, which should follow v. 6. Natives sing the verse that comes first to mind; so that we may find the song very puzzling on this account.

7. *Moons or Months.* The following is a table of names:—

No.	Weasisi Name.	Kwamera Name.	Adeldc Date	Jewish Name.
			1886 It began.	
1	Mauk-imei	Kuramai	July 31 ...	Ab.
2	Mauk-itau.......... .	Taneyau (?)	Aug. 29 ...	Elul.
3	Mauk-eibiung	Kakuseriakuseri ...	Sept. 28 (?)	Tisri.
4	Mauk-laulau or lulu	Kurarurar	Oct. 27 ...	Hesvan.
5	Mauk-luslus	Tamtamuku	Nov. 26 ...	Kislev.
6	Veritum..............	Veretam...............	Dec. 25 ...	Tebet.
7	Naungwa	Nahua	Jan. 5 (24)	Sebat.
8	Veru	Veru	Feb. 4 (23)	Adar.
9	Yati	Tamtamanen.........	Mar. 6 (25)	Nisan.
10	Neusi..................	Neuvsi	Apr. 4 (23)	Yiar.
11	Keafakelabakel ...	Pakerpaker	May 4 (23)	Sivan.
12	Kaiyahnulul.........	Kamneru	June 2 (21)	Tamuz.

Notes on the Months.

(1.) *Mauk-imei.*—See (2) under general remarks for *mauk. Imei* seems to mean "a field." A piece of ground is *numei.*

The word is prefixed to the names of tribal districts, *e.g.* Numei-Kasarûmhni, "the land of the Kasarûmeni." A roof-gutter is a *numei nanû*, "the place of water." The grate of a stove is a *numei ningum*, "the place of fire;" literally it is "*moon of the field*." Natives begin to prepare new plantations. I identify it with *kuramai* of the *Kw* dialect. Two moons may pass by under this name.

(2.) *Mauk-itau.*—The moon for making mounds in which the yam is planted. These mounds are called *nitau*, "a hillock." In 1890, *Mauk-itau* began in the end of September. I am not certain that Taneyau is its equivalent in the Kwamera dialect.

(3.) *Mauk-eibîung.*—The moon for training the yam tendrils. A staging of reeds is made as shown here, and on this the yam tendrils are trained. To do this is to *eibîung*. The Kwamera name, I take it, means to "tie with a rattan,"—*akûs*, "a rattan," *ehrî*, "to tie." In 1890, this month began on October 16th.

(4.) *Mauklaulau* or *Mauklûlû.*—There is some uncertainty about the meaning of this name. I first took the name to describe the state of yam tendrils which cover everything, as melons cover the ground where they are planted. But it may have reference to the work of the month—"hoeing," from *kahlû*, "a hoe." This agrees with the Kwamera name, *kurarurar*, which means "hoeing." In 1890, this moon began November 13th.

(5.) *Mauklûslûs.*—*Lûslûs* is the term applied to the yam "seed." The new yam roots have begun to form and the plant is independent of its parent "seed," which the natives now remove. In cases where a whole large yam has been set, the yam will be quite good. It is taken away to be used for food. This moon name runs a great risk of being left out of the count; I identify it with *Tamtamuku* in Kwamera dialect. Compare Weasisi *tumnumût*, "rotten." It is the end of the old days.

(6.) *Verîtum.*—Everything is full of sap, vegetation luxuriant, rain abundant. Given to Mr. Watt (Kwamera) as a month of the *old days*. Food is plentiful. *Terum* means to be "full of water," as a water-hole, cup, or basin.

(7.) *Naungwa.*—It is described by natives as the month when the trees are forming their fruit. It is given by the Kwamera natives as a moon of the *old days* which it can hardly be, unless we make a difference of two or three months in reckoning. That is the Kwamera people are that much

earlier than the people here. Nahua is their name for it. *Nowan* is a general term for fruit of a tree; *aua* is to bear fruit; Kwamer dialect *núhwan* and *úkúa* are the corresponding words. Doubtless there is but one root in the name of this moon and in the words just given. Hence we translate it as "the fruiting moon." It is to be observed that there is not space for a moon in the list between December 25th and January 5th. The explanation is that I began to keep a record of the moons beginning with January 1886 and afterwards arranged the list to suit the Tannese year. Hence Naungwa would begin January 24th, 1887. To remove this difficulty, let the reader begin with Naungwa.

(8.) *Nerû.*—Same name in both dialects. The only clue that I have as yet to the meaning is in the adjectives *bikis* "immatured," and *matû* "dry ripe." That is, during this moon the fruits may be immature or they may be dead ripe. In 1889, it was a *bikis* moon.

(9.) *Yatî.*—The first yams are ripe and the name seems to have reference to the tubers going down into the soil on end. I have set down Kwamera *Tamtamanen* as its equivalent though I have no reason for connecting the names except that the Kwamera people speak of watering (kamufî) the yam. This probably is a phrase to describe some ceremony performed to cause the yam tubers to swell out. This or the month earlier would be the time when this would be done. So here, *kûverî nimê*, "soak the breadfruit," which is such a ceremony as the above.

(10). *Neusî.*—Same name in both dialects, and same occupation—dancing. I derive the name from *us tâka*, name for "dancing" with a certain kind of club, the tâka. These dances are practised for several weeks and end in a feast. These dances were in full swing in the end of April and beginning of May this year (1891).

(11.) *Kêafakelabakel.*—The Kwamera name would indicate, I think, a reference to sandiness. Two kinds of yam are ripe, *namû*, and *kauyehê*. The people at Kwamera made this month begin in 1889, on July 28th. But the people a little west of Kwamera held that *Kuramai* began that date. But both agreed as to what was done during *Pakerpaker*. No cultivation goes on.

(12.) *Kaiyahnúlúl.*—I put down here the Kwamera *Kamnerû* simply because I have no other place for it. It is said there is one name wanting in the Kwamera list. But this is doubtful. The difficulty of 12 moons instead of thirteen is not

felt, because when there is doubt, two moons are put under one name. I know neither the meaning of *Kaiyahnûlûl* nor *Kamnerú*. During *Kaiyahnúlúl* the plantations are neglected, the ground is dry and dusty. Compare *maulûlúl*, "dust." But the natives told Mr. Watt that, during *Kamnerú*, the yams were all planted and the food was scarce, which would indicate a position for it between one and four. *Kaiyah-núlúl*, I find, may mean "gathering up little sticks," and may have reference to the practice of gathering up the reeds of which the yam trellis are made. See Fijian dictionary under Vula.

Some general remarks.—1. The natives have various ways of reckoning the seasons and year. A common one was to speak of the *old* and *new* days. The "new days," *nîyan ivî*, are reckoned to begin about December and end in June. There is, however, no certain date. Natives are guided in speaking of these seasons by the state of vegetation. When trees and plants begin to grow anew, they say the "new days" have come. Again, they speak of the "long" and "short" days. The "long days," *nîyan rurus*, are from the end of October to the middle of February. The natives during this period can take two spells of work in their plantations—one in the forenoon, rest in the heat of day, and work again in the afternoon. About March 21 and Septem-20 the day is exactly 12 hours long, the sun rising and setting at six o'clock. About December 22 the day is 13h. 12m. long; about June 21 the day is 11h. 48m. long. The years are counted by the number of yam crops. Practically the year begins with Maukĭmeĭ, the end of July. That is the time when the natives begin their new plantations.

(2.) It will be noticed that in the names of the moons, *mauk* or *mauuk* (mauung = "moon," Weasisi dial., but *mokwa*, in Kw. dial.) is prefixed from one to five. This corresponds to what the natives call the *old days*, nîyan nowas. But the *k* may belong to the verb = kĭmei, etc. Then translate, for the field, for training, etc.

(3.) A moon is named according to the state of vegetation. Hence, a moon may be shifted back or forward or drop out of count. In 1889 Mauklúlú and Mauklûslûs were put together. Indeed it may be Mauklúlû in one district, and Mauklûslús in another. See also under 11.

(4.) It is only the older people who know the names of the moons, or which is which. And indeed there is often much difference of opinion among these as to which is which moon.

On Aimoa—a Mahori colony—there are no such names. The moons are named on Erromanga and Futuna (?). Whatever the importance attached to these names in past ages very little notice seems to be taken of them now.

8. *Winds.*—Terms of navigation. These must go together, for it is likely that some names of minor winds are terms used in navigation. There are four main winds—Lûatû, Tonga, Tŭkalau, and Balabû.

(1.) Luatu embraces all winds from N.W. × N. to N.E. × N. It is comprised of the following winds :—*Luat-matûa* (matua is to steer a canoe with the paddle, the helmsman sitting in the stern with the paddle in the water close by the side of the canoe. The effect is that of a fish fin). It extends from N W. × N. to N. × W. *Lûatû-alalî* (the Luatû turning round) from N. × W. to N. × E. *Lûatû-ûmlai.* I do not know the meaning of umlai. But this wind is specially humid. It extends from N. × E. to a little past N.N.E., *Lûat-natonga.* It is the junction of Lûatû and the Tonga. From a little E. of N.N.E. to N.E. Atû, in this dialect, means "to belay" a rope. Whether the fastening of a rope gives the name to the wind or the wind gives the term used for fastening a rope, I cannot say. But in certain circumstances a canoe would go on with no more trouble to the mariners than the setting and fastening of the sail.

(2.) *Tonga.* This is a word appearing all over the Pacific, varying in form and meaning. Here it is the name of the wind from N.E. × N. to S. × E. And if we identify Tŭkâ (lau) with Tonga then we must include the wind round to S.W. × W. Meantime I exclude Tŭkalau. The Tonga, however, must be divided into two parts :—

(*a.*) *Natonga.* From N.E. × N. to E. × S. The sub-winds of this division are neither numerous nor well defined. First we have *Luat-natonga,* bordering on the Lûatû. Then *Natonga rûan,* "the *white* natonga," about E.N.E., and *Ulîtonga* Natonga, bordering on the *Ulî-tonga,* about E. × S.

(*b.*) The Ulî——. From E. × S. to S. × E. The sub-winds are numerous and well defined, which is always the case with the people who get their winds over the land, from adjacent islands, or through straits. This is not so when the winds come off an expanse of ocean. The sub-winds are :—*Ulî-tonga-natonga* or *um natonga,* from E. × S. to a little south of E.S.E. *Ulî-tonga-Pitan* (Ulî-tonga woman), about S.E. × E. *Ulî-tonga Yerûman* (U. t. man)

about 1° S. of S.E. *Ulî-fafa* (fafa is the name of a wood brace used to support the mast in the rig of a native canoe) is a wind between S.E. × S. and S.S.E. There is also the term "tataiyû rafafa or rafara" which I would translate, "running with the fafa set." (Fiji, *papa*, "a board").

(3.) *Tukalau.*—Tokalau is given in Fijian as the east wind, natokarau as N.W. wind on Aneityum. Here it is certainly a S. wind, extending from S. × E. to (uncertainly) S.W. × W. The sub-winds are:—*Ulî-tonga um Tukalau*, bordering on the *Ulî-tonga*, about S. × E. to S. × W. *Balab-tukalau*, is one of great uncertainty as to limits, and extends from S. × W. to S.W. × W.

(4.) *Balabû.*—This extends from S.W. × W. to N.W. × N. A Balabû always produces a smooth sea here, but it is at the same time a fine sailing breeze. Aneityum, noperîhapu is a N.N.W. wind. *Bale* may be from the root of a word used here to describe the rough sea falling. (See *bale*, Fiji, "to fall.") Abû may be the root which signifies dark, cold, &c. The sub-winds must be put in two classes:—

(*a.*) *Balabu.*—These are Balab-tŭkalau as given above. Then *Balab matûa* (Matûa, Samoan, north wind), about W.S.W. *Balab-luanîanî*, between W. × S. and W. *Balabû-aben* (black), about W. × N. *Balab nîsî*, about N.W. × W.

(*b.*) *Tukalautû.*—Compare Fijian Tokalaulutu, N. or N. E. wind, Samoan To'elau and To'elau-lafalafa, N.E. wind; Aneityum (see the whole list in Dict., p. 113), Natakarau, N.W. wind. The surprising thing is that a Tukalau should be put in this side of the compass.

9. *Terms of Relationship and the Law of Marriage.*

1. Aunt.

A person can have no aunt. The relative we so call must be (1) a mother. *Iten* (ri'nî, Kw.; nana, An.) is the term used to speak of another person's mother. It is applied to a man's own brother, and to the sisters of his mother, and to the wife of his father's brother. The person himself would call such a person *Yuma* (mama, An.) In the Kwamera dialect a child would say *Nana*, one more grown would say *Yuma*, and an adult would say *Ka'na*. (2) She must be a mother-in-law. *Uhûn* (Cúsiî, Kw.; nanfagavai, An.) is the term used to speak of the sister of a man's father or the wife of the brother of a man's mother. (See Mother.)

2. BROTHER.

(*a.*) *A Man's Brothers.*—(1) *Pian* (piavini, Kw.; nŏsoa, An.) A man's brother (and a woman's sister) without considering whether the brother is senior or junior.* Likewise all male cousins who are children of the brother of a man's father, or the sister of a man's mother, are his brothers. (2) But *Noatún* is used for any such brother who is older than the man himself. (Breianî, Kw.; nŏsoatasore, An. The same term is used for a woman's elder sister.) (3.) And *Noatahan* (brasînî, Kw.; nŏsoatasore, An.) is used for any such brother (in the case of a woman for her younger sisters) who is younger than the man himself.

(*b.*) *A Woman's Brother.*—*Nomanin* (pomanî, Kw.; nokave, An.) is the term used for a woman's brother of any age, and for her cousins who are sons of her mother's sister or of her father's brother.

3. BROTHER-IN-LAW.

(*a.*) *A Man's Brother-in-law.*—*Nevin* (yafûnî, Kw.; nosafe, An.) is the brother of a man's wife (and is the man's cousin) and the husband of a man's sister (also a cousin). This is brought about by the marriage law. A man may take to wife the daughter of his father's sister, but not the daughter of his father's brother; she is counted to be his sister. Or he may take to wife the daughter of his mother's brother, but not the daughter of his mother's sister; she is his sister.

(*b.*) *A Woman can have no Brother-in-law.*—The man that can take her sister to wife can be her husband. So can the brother of her husband be her husband. They are her cousins, and must be either sons of her father's sister or her mother's brother. See diagram under WIFE.

4. CHILD.

(1.) *Púti* (Kw., small; so far as I know there is no such distinction in W. dial.; tĕntamanêa, An.) is the young of lower animals while "small." (2.) A child without reference to sex or parentage, *Netin* (tĭnĭ, Kw.; tentama, An.) (3.) A child distinguished in sex but not parentage. Male child, *súahakakú* (yakun auhî, Kw.; tausêvîasîsî, An.); a female child, *pitakakú* (bran auhí, Kw.; nofîne, An.) (4.) A child distinguished by the sex of the parents—(*a*) A son is the *yamatî* of a man and the *yakûtî* of a woman (notarikî and

* Pian is rather a companion, contemporary, neighbour, than a relative.

tĕntama, An.) There is no such distinction in the W. dial. (*b*) A daughter is the *bratî* (nofine, An.) of a man and the *yakûtî* (tĕntama, An.) of a woman. No distinction is made in the child of the woman. No such distinction in W. dial. (5.) A parent, father or mother, addresses his male or female child as nĕtĭk (narĭk, Kw.; tukûtariki, An.) (See Son, Daughter, Cousins.)

5. Cousins.

Are either (*a*) sacred, *nevin* (husband and wife's brother), *neowun* (wife and the husband's sister). Such persons are sacred to one another. For example, A is the husband, B the wife, C the wife's brother. In the presence of C both A and B must be modest in dress, speech, and behaviour.

(*b.*) *Marriageable Cousins.*—Sisters' children do not marry one another; they are counted brothers and sisters. Children of two brothers do not marry, they are brothers and sisters. But the children of a man can marry the children of his sister.

6. Daughter.

For the terms see under Child. A man calls his own girls and the girls of his brother his daughters. A woman calls all her own girls and the girls of her sister her daughters. The man and woman are in turn called father and mother.

7. Daughter-in-Law.

(*a.*) A man's daughters-in-law are his nieces who are daughters of his sisters or cousin-sisters, or wife's brother—*ra'niau anîen* (same term for sons-in-law, kŭnkanîen, Kw.; noraimûtû ———— An). They can become the wives of his sons.

(*b.*) A woman's daughters-in-law are the daughters of her brother or husband's sister — *nau'wein* (brasîni, Kw.; nosoatasore (An). But the same term is used for the nephews also.

8. Father.

(1.) *Tata* (tara, Kw.; tata, An.) is the term a man or a woman uses when speaking of his father. (2.) *Timin* (rimini, Kw.; tamana, An.) is used when a man speaks of the father of another person. Same term is used by women. (3.) A man's father, his father's brothers, and his father's cousin-brother's and the husbands of his mother's sisters, are his fathers. The same with the woman.

9. Father-in-Law.

(*a.*) A man's father-in-law—Un (mĕraní, Kw.; to'mana, An.) He may be the brother or cousin-brother of his mother, or the husband of his father's sister or cousin-sister.

(*b.*) A woman's father-in-law must be her mother's brother or cousin-brother, or the husband of her father's sister or cousin-sister. The same terms are used.

10. Grandchild.

Numwîpon (mîponî, Kw.; tampûpûna, sing., fatupûpûna pl. An.) is the term, but the sexes are not distinguished.

11. Grandfather or Mother.

(1.) *Kaha* (Kw.; pua' An.) is the term a man uses to speak of or to his grand-parents. (2.) Tupun (rûpûnî Kw.; tûpûna, An.) is the term a man uses in speaking of the grand-parents of others.

12. Husband.

Ra'neauwa'lî (kunsûarû, Kw.; nenûane An.) is the term used for a woman's husband. But it applies to all his brothers. A woman can marry any of her cousins who are sons of her father's sister or mother's brother.

13. Mother.

(1.) *Yuma* (W. and Kw.; mama, An.) is the general term used by a man or woman speaking of one's mother. In the Kw. dialect a child will say, *Nana*, a person more grown will say, *Yuma*, an adult will say, *Ka'na*.

(2.) *Iten* (ri'nî, Kw.; Nana, An.) is used when one speaks of the mother of someone else. (3.) A man's own mother, the sisters, or cousin-sisters of his mother, and the wives of his father's brothers are his mothers. So with the woman.

14. Mother-in-Law.

(*a.*) A man's mother-in-law—Uhûn (cusî, Kw.; nennanfagavai, An.). She must be his father's sister or cousin-sister, or the wife of his mother's brother or cousin-brother. A man has the right to take to wife the daughters of all such persons. See diagram.

(*b*). The same term is used for a woman's mother-in-law, and the relatives are the same.

15. Nephews and Nieces.

(*a.*) Those that are sons and daughters. The children of a man's brother, or cousin-brother, and the children of a

woman's sister, or cousin-sister, are counted as sons and daughters. And the terms used for children of a man or woman are used for such nephews and nieces. See CHILD.

(*b*.) *Nephews and Nieces who are Sons-in-law and Daughters-in-law*.—(1.) A man's nephews and nieces are called *Ra'níauanien* (kŭnkwanien, Kw.; novaimutu, An.) There is no distinction of male and female. These are the children of a man's sister or cousin-sister, or woman's brother or cousin-brother. (2.) For the same children a woman uses *Nau'wein* (brasînî, Kw., the term for younger sister; nŏsoatasîsi, An.) These nephews and nieces become the sons-in-law and daughters-in-law of a man and his wife. These terms are applied to them, though the marriage with the children of the man and his wife may not be consummated.

16. SISTER.

(*a*.) *A Man's Sisters*.—*Náuvenin* (pîvînî or pînî, Kw.; nokave, An.) is the daughter of a man's own mother, the daughter of any other woman who is the wife of his father, the cousin who is the daughter of his mother's sister or cousin-sister, the cousin who is the daughter of his father's brother or cousin-brother.

(*b*.) *A Woman's Sisters*.—(1.) *Pían* (pîavînî, Kw.; nŏsoa, An.; see BROTHER *a*. (1.) is used for sister or cousin-sister without considering whether senior or junior. A woman's sisters are her own sisters, the daughters of her father by any other woman than her mother, the daughters of her father's brother or cousin-brother, and the daughters of her mother's sister or cousin-sister.

(2.) But *Noatún* (breianî, Kw.; nŏsoatasore, An.) is used for any such sister who is older than the woman herself.

(3.) *Noatahan* (brsînî, Kw.; nŏsoatasisi, An.) is used for any such sister who is younger than the woman herself.

17. SISTER-IN-LAW.

(*a*.) A man can have no sister-in-law. That relative (his wife's sisters or his brother's wife) can be his wife—*núwein*.

(*b*.) A woman's sister-in-law (her husband's sister or her brother's wife) is *Neauwun* (Pûrkûmani, Kw.; rŭfeima, An.; dual, noma. sing.) It is the corresponding relation that makes a man's brother-in-law, which see.

18. SON.

For terms, see CHILD. A man calls his own son, the sons of his brother or cousin-brother, and the sons of his wife's

sister or cousin-sister, his sons. Likewise the woman calls her own son, the sons of her husband's brother or cousin-brother, and the sons of her sister or cousin-sister, her sons. (See DAUGHTER.)

19. SON-IN-LAW.

(*a.*) *A Man's Sons-in-law—Ra'nîauanîen* (see NEPHEW and NIECE.—A man's sons-in-law (the same term is used for his daughters-in-law) are the sons of his sister or cousin-sister, and the sons of his wife's brother or cousin-brother.

(*b.*) *A Woman's Sons-in-law—Nau'wein.*—They are the sons of her brother or cousin-brother, and the sons of her husband's sister or cousin-sister. The same term is used for a woman's daughter-in-law.

20. UNCLE.

A person can have no *uncle.* That relative must be (1) a father—tĭmĭn (father, father's brother or cousin-brothers, and a mother's sister's husband, or the husband of her cousin-sister.

21. WIFE.

The term is *Núwein* (rukweinî, na'npitaugwa'tî, kŭnbranêma, Kw.; tafoinafûnê, nanufûnê, An.) *Nuwein* is always the man's cousin, the daughter of his father's sister or cousin-sister, or the daughter of his mother's brother. The law of marriage is that the children of two brothers or two sisters do not marry; they are counted as brothers and sisters. But the children of brothers and sisters marry. The children are betrothed in infancy, and are expected to wed when grown up sufficiently. Cousins who are children of brothers or children of sisters, and adopted children are reckoned as real children. Tannese rarely marry any one outside the common marriage law—that is, a stranger. Rather than do this they will marry a forbidden relation. Men have taken to wife a niece who was the widow of a deceased son. In fact every relationship, except that of brother and sister by the same mother, is at times ignored.

The following diagram illustrates the source from which a man's son can take a wife. HSH = the husband's sister's husband; HS = husband's sister; HB = husband's brother; HBW = husband's brother's wife; H = husband; W = wife, and so on. S = son; d = daughter. HSH, &c. are contemporaries.

Had time permitted I would have examined the principles on which these relations are based and the terms used to

express them. In order to make reference easier, I add a Vocabulary of Terms.

In regard to these notes I must acknowledge my obligations to Mr. and Mrs. Watt, our co-workers on Tanna. More especially is this the case in respect to my notes on winds and relationships. If I have failed to state correctly the information thus obtained, it is because I have failed to remember or grasp what I have been told; but I have taken great care to be as correct as possible.

The Vocabulary of Terms.

1. Brasînî (Kw.), see noatahan.
2. Bratî (Kw.), in the Kwamera dial., is the daughter of a man (see Gen. 20 15, "Brati tara, mata repuk-o'ma yakuti ka'na"). See daughter, son, and native names forthese. No'tama, Aniwan word.
3. Breianî (Kw.), see Notûn.
4. Cusì (Kw.) See ûhûn.
5. Fatûpûpûna (An.) See grandchild.
6. Iten, his mother. See mother.
7. Kaha, my grandfather, my grandmother.
8. Ka'na (W. and Kw.), my mother. Used by an adult speaking of his mother.
9. Kŭnkwanîen (Kw.) See nephew.
10. Kŭnsûarû (Kw.) See husband.
11. Mama (Aniwan). See mother.
12. Mĕranî (Kw.) See father-in-law, mother-in-law.
13. Nana (Kw. and An.) See mother.
14. Nanŭfûnê (An.) See sister-in-law, wife.
15. Nanfagavai (or nemfagavai) (An.) See mother-in-law.
16. Narĭk (Kw.), my child. See child, son, daughter.
17. Nau'wein, a woman's nephews and nieces who are children of her brother. Therefore her son or daughter-in-law, which see.
18. Náuvenĭn, a man's sister. See sister.
19. Neauwun, the sister of a woman's husband or her brother's wife. See sister-in-law.
20. Nĕtĭn, the child of either man or woman, whether male or female. See child.
21. Nĕvin, the brother of a man's wife, and the husband of a man's sister. See brother-in-law.
22. Noatahan, a man's younger brother or a woman's younger sister. See brother and sister.

23. Noatún, a man's elder brother or a woman's elder sister. See brother and sister.
24. Nofíne (An.) See child, daughter, son.
25. Nokavê (An.) See brother.
26. No'ma (An.) See sister-in-law, husband.
27. No'tama (An.) See daughter.
28. Nomanin, a woman's brother of any age. See brother.
29. Nontariki (An.) See child, son.
30. Nosafe (An.) See brother-in-law.
31. Nŏsoa or Nŏsot (An.) See brother, daughter-in-law, nephew, sister.
32. Noraimutû (An.) See nephew.
33. Numwípun, a man or woman's grandchild, male or female. See grandchild.
34. Nuwein, a man's wife, her sisters, the wife of his brother, cousins who are daughters of the sister of a man's father or daughter of the brother of a man's mother. See sister-in-law.
35. Pían, a man' brothers of any age, a woman's sisters of any age. It means the one who is a man's equal. See brother, sister, cousin.
36. Pîavînî (Kw.) See brother, sister.
37. Pitakakû, female child; pl. Pitalkala'.
38. Pîvînî (Kw.) See sister.
39. Pomanî (Kw.) See brother.
40. Pua' (An.) See grandfather.
41. Pûrkûmanî (Kw.) See sister-in-law.
42. Pûti (Kw.) Used of the young of lower animals while small. See child.
43. Ra'neauwa'lî, husband, a woman's cousins who are sons of her father's sister or mother's brother.
43A. Ra'nîauanîen, the children of a man's sister or wife's brother, male or female. See nephew, younger sister, son-in-law, daughter-in law, nieces.
44. Ri'nî (Kw.) See mother.
45. Rĭmĭnî (Kw.) See father.
46. Rûkweinî (Kw.) See wife.
47. Suahakakû, a male child, pl. Sua'lkala'. See child.
48. Tamana (An.) See father.
49. Tampûpûna (An.) See grandchild.
50. Tara (Kw.) See father.
51. Tata (W. and An.), my father. See father.
52. Tĕntama (An.) See child, son, daughter.
53. Tentamanêa (An.) See child.

54. Tĭmĭn, a man or a woman's father. See father.
55. Tĭnĭ (Kw.) See child.
56. To'nana (An.) See father-in-law.
57. Tupûn, a man's grandfather or mother. See grandfather.
58. Tupûna (An.) See grandfather.
59. Uhûn, mother-in-law, the sister of one's father, the wife of the brother of one's mother. See aunt, mother-in-law.
60. Un, father-in-law, the brother of one's mother, the husband of the sister of one's father. See father-in-law.
61. Yafûnî or Yafwênî (Kw.) See brother-in-law.
62. Yakûtî (Kw.) The child (male or female) of a woman. See child.
63. Yamati (Kw.) The son of a man. See child.
64. Yuma, my mother. See mother.

6.—NOTES ON THE LOYALTY ISLANDS.

By REV. S. M. CREAGH.

AT the Isle of Pines, which is near the southern end of New Caledonia, but is not in the Loyalty Group, the people practice *in*cision. In the Loyalty Islands they had a practice which can neither be called *cir*cumcision nor *in*cision; young men before marriage, and as a preparation thereto, were accustomed to separate the prepuce from the glans penis by severing the frenum preputii; this was done by piercing the f.p. close to the g.p. with a thorn from the orange tree, and inserting a string which was tied tightly to stop the circulation, and in a few days the separation would be effected without any further trouble; this was done to prevent, as they supposed, any evil consequences. Since the introduction of the Gospel the natives have of themselves discontinued the custom.

There are no marriage laws; it was, however, the custom in certain cases to betroth a child as soon as it was born to some man or boy of importance. Property was given to the father of the child by the friends of her intended husband; in due time, when the state of puberty had arrived, the girl was taken to the home of her future husband; no marriage ceremony took place, but property was again given to the

girl's parents; this giving of property was again repeated on the birth of her first child; from that time, on Maré particularly, the woman is no longer called by her own name, but by that of her child's name—the "mother of Ada;" the father's name also is dropped, and after the birth of his first child he becomes, say, "father of Ada." This custom also obtains in South Africa. You may have observed it in Livingstone's work, the "Zambesi and its Tributaries." Indeed the woman's name is dropped before the birth of her child; as soon as it is observed that she is *enciente* (and that was seen very soon in a place where they wore no clothing whatever), she was called by that appellation—"*enciente*." The husband is expected to make frequent presents of property or of food to his wife's relations; he never gets any dowry; he may be said to purchase his wife, as it is supposed that he is the only gainer by the connection; he is always liable to be called upon to perform any service which may be demanded of him by his wife's friends. Daughters were considered a source of profit to their parents; and yet boys are always preferred to girls. According to the native idea you would suppose that every child born ought to be a male; if the child happens unfortunately to be of the other sex it is a mistake; the sex has been changed through the wantonness of the mother after she became *enciente*.

No tutelary animals or birds employed. The presence of certain birds and lizards was supposed to indicate the nearness of a spirit or god; the kingfisher was one such bird, the owl another; no one had the courage to eat these birds.

The numerals are:—

Maré.

1 sa, 2 rewe, 3 tini, 4 eche.
five and one.
5 sedongo, 6 sedongo ne sa.
five and two. five and three.
7 sedongo ne rewe, 8 sedongo ne tini.
five and four. two bunches of fingers.
9 sedongo ne eche, 10 rue tubenin.
two bunches of fingers and one.
11 ruetubenine ne sa.
ditto and two.
12 ruetubenine ne rewe.
ditto and three.
13 ruetubenine ne tini.
ditto and four.
14 ruetubenine ne eche.

two bunches of fingers and five.
15 ruetubenine ne sedongo.
two bunches of fingers and five, and one.
16 ruetubenine ne sedongo ne sa.
ditto ditto two.
17 ditto ditto rewe.
ditto ditto three.
18 ditto ditto tini.
ditto ditto four.
19 ditto ditto eche.
one man. one man and one.
20 sarengom, 21 sarengome ne sa.
one man and two bunches of fingers.
30 sarengome ne ruetubenin.
two men.
40 rewerengom.
two men and two bunches of fingers.
50 rewerengome ne ruetubenin.
60 three men, tinisengom.
three men and two bunches of fingers.
70 tinirengome ne ruetubenin.
four men.
80 echenegom.
four men and two bunches of fingers.
90 echerengome ne ruetubenin.
five men.
100 sedongore ngom.

Lifu.

1 chasi, 2 luete, 3 könite, 4 ekete.
one and the before-mentioned.
5 tripi, 6 changemen.
two and the before-mentioned. three and the before-mentioned.
7 luengemen, 8 köningemen.
four and the before-mentioned. two fives.
9 ekengemen, 10 luepi.
two fives and one. one toe.
11 luepi nge chasi, or chako.
two toes.
12 luepi nge luete, or luako.
three toes.
13 luepi nge könite, or köniko.
four toes.
14 luepi nge ekete, or ekako.
three fives.
15 könipi.
16 chaqaihano.
17 lueqaihano.
18 köniqaihano.

19 ekeqaihano.
one man.
20 caate.
one man and two fives.
30 caate nge luepi.
two men.
40 luate.
two men and two fives.
50 luate nge luepi.
three men.
60 köniate.
three men and two fives.
70 koniate nge luepi.
four men.
80 ekate.
four men and two fives.
90 ekate nge luepi.
five men.
100 tripi lno ate.

I have not given you the Ouvean numerals, because I don't know the language; if you desire those numerals and pronouns, Mr. Ella, of Petersham can give them; he was the missionary on that island for many years. Above, in the Lifu, the number six changemen, is composed of cha, abbreviated form of chasi, one; nge, conjunction, and; men, the before-mentioned, indicating that five is the quantity; men would never be used to indicate ten, or fifteen, or any number but five. Six may also be written, sarechemen, in the *Maré* dialect, which is composed of sa, one; re, connecting particle (or perhaps the conjunction ne, and, changed into re; re sometimes and in some connections is the possessive; re never indicates a conjunction except in the numerals), and chemen, which means, as the "men" in Lifu, the before-mentioned number five. Again, 11, chako, Lifu is really one toe; when the toes are used for the process of counting it indicates that the fingers have been counted already; chako, one toe, can never mean *one* only, but always eleven, ten and one.

The following are the pronouns:—

Maré.

Nominative case—
Sing. 1st per. inu.
chiefs common abusive.
Sing. 2nd per. bua, nubo, ehme.
common abusive.
Sing. 3rd per. nubone, iche.

Dual 1st per. incl. ethewe, including person spoken to.
Dual 1st per. excl. ehne, excluding person spoken to.

common abusive.
Dual 2nd per. hmengo, buhme.

common abusive.
Dual 3rd per. bushengone, buhme.

Pl. 1st per. incl. eje, including person addressed; excl. ehnije, excluding person addressed.

common abusive.
Pl. 2nd per. buhnije, ziehme.

common abusive.
Pl. 3rd. per. buice, züche.

Lifu.

Nominative case—

Sing. 1st per. ini.

highest lowest.
Sing. 2nd per. enëtilai, nyipë, eö, hmunë, hnam.

highest lowest.
Sing. 3rd per. nyidë, angeice, nyën, ic, eje.

Dual 1st per. inclusive nyisho, including person addressed; excl. nyiho, excluding person spoken to.
Dual 2nd per. nyipo.
Dual 3rd per. nyido.

common higher.
Pl. 1st per. incl. eëshë nyishë, including person

common higher.
addressed; excl. eëhuni, nigihume, excluding person addressed.

higher common low.
Pl. 2nd per. nyipunie, nyupun.

higher common low.
Pl. 3rd per. angale, nyuden.

Maré.

Possessive case—

Sing. 1st per. go, a suffix as in Hebrew, thus—hawo, head; go, my; hawogo, my head.
Sing. 2nd per. ni nubo, of thee; hawo ni nubo, head of thee, or thy head.
Sing. 3rd per. ni nubon, hawo ni nubon, his head.
Dual 1st per. incl. ni ethewe, ceceni ethewe, our father; exclu. ni ehne, ceceni ehne, our father.
Dual 2nd per. ni hmengo, ceceni hmengo, your (2 persons) father.

Dual 3rd per. ni bushengon, ceceni bushengon, their (2 persons) father.

Pl. 1st per. incl. nieje, or je, only, cecej, our father, lani eje, or laje, our way; exclu. ni ehnije or hnije, node ni ehnije or nodehnije, our land.

Pl. 2nd per. ni buhnij, toto ni buhnij, your garden.

Pl. 3rd per. ni buice, toto ni buic, their garden.

Objective case—

Sing. 1st p. nu.

In all the other persons the form is the same as the Nominative, except sometimes the eje and ehnije take the guttural x before them, thus—xeje, and xehnije.

Lifu.

Possessive case—

Sing. 1st per. nge, suffix, my; henge, my head.

Sing. 2nd per. i nyipë; he i nyipë, thy head.

Sing. 3rd per. i ange; heic i angeic, his head.

Dual 1st per. i nyisho, or sho; keme sho, our father; inclu. hlapa i nyisho, our garden; exclu. i nyiho, or ho; hlue i nyiho, our servant; keme ho, our father.

Dual 2nd per. i nyipo; keme i nyipo, your father.

Dual 3rd per. i nyido; keme i nyido, their father.

Pl. 1st per. incl. i eëshë, or shë; keme-shë, our father; exclu. i eehuni, or hun; kemehun, our father.

Pl. 2nd per. i nyipunie; ixete i nyipunie, your clothes.

Pl. 3rd per. i angate; uma i angate, their house.

Objective case—

Sing. 1 p. ni.

In all the other persons the form is the same as the Nominative, except sometimes the first persons in the dual and plural; they are more frequently shortened, thus—sho and ho; shë and hun.

A peculiarity in Lifu is to use the dual pronoun in speaking of and to a woman who is a mother; her child is supposed to be with her always; even she herself uses the dual pronoun in speaking of herself.

There is another matter in connection with the pronouns worth mentioning. You will observe that the 2nd per. sing. in the Maré has three words, viz., bua, nubo, ehme; all mean the same thing, "thou;" but they are addressed to persons in different relations or status in life; bua is used to chiefs by his people; "nubo" is the common and ordinary pronoun, used by everybody to everybody in equal stations in life; it

is very frequently abbreviated into "bo;" "ehme" is the pronoun a father uses to his child; it is used also in abuse. The third person sing. also has two pronouns used in the same way—"nubon" and "ich." The second and third per. pl. are "buhnije," "ziehme," and "buice," "ziich" respectively.

In the Lifu language we have five pronouns in the 2nd and 3rd per. sing. respectively; 2nd per. "enëtilai," is the most respectful, "hnam" the most contemptuous. 3rd per. "nyidë" (sometimes "anga" is prefixed, which adds to its dignity) is the highest; "ej" ("j" is pronounced as "th" in thine) is the lowest; indeed, "ej" is the only neuter pronoun in the language in any person; a plural article added to "ej" makes it plural thus—"it'ej," things.

I will take your questions seriatim.

1. Sedongo = 5. I know of no derivation for this word. I consider it *five*, as *rewe* is the word for *two*; but, *dongo* is famine, and *se* the indefinite article; according to that *se dongo* would mean *a famine*; there can, however, be no connection between five and a famine.

2. Sarengome = 20 = one man; perhaps the translation should be more properly—one person, *ngome* is the word for person (the generic word for man), male or female; but cahman, male or man; hmenewe, female or woman.

3. Rue tubenin = 10; tube = bunch, nim = finger; tube is, I think, derived from the verb *tebon*, to tie in bundles; nin is never used alone to indicate finger, but the diminutive particle "wa" is always added, thus *wanin*, which may be a finger, the hand, or the whole arm from the shoulder to the fingers; then *ara* is added to indicate the palm of the hand and the sole of the foot:—*aranin*, palm of hand; *arada*, sole of foot.

4. Is *n* or *in* ever used as a suffix pronoun as in the New Hebrides? In the Maré and Lifu, no; but in the Uvean language the *n* is the third per. sing. suffix to nouns.

5. In ethewe and rewe, is the ew = the sound of English *rue* or *Yew?* No. The combination *ewe* does not occur in a large number of words, but it is always the terminal of a word; it cannot be well represented by any English letters. All syllables (except the ultimate) in the Maré and Lifu languages are open, that is, end in a vowel; the natives cannot pronounce two consonants one after the other, without a vowel between; in many words the ultimate ends in a consonant, where the sentence is finished; hence, ethewe is divided thus, e-the-we, also hme-ne-we, woman in ethewe the middle e will go with

the preceding consonant, and the we is the only combination to be considered, the nearest sound of which that I can think of is the *we* in the word "went," only the e must scarcely be perceived.

6. Is j always=th? In the Maré language the j is never =th, but is uniformly sounded as soft g in genius. In the Lifu language, however, the j has been adopted to represent *th* as in *that*.

7. Is ë=e ay and ö=German ö? ë in Lifu is not any sound in the English language, but is very near the *eu* in French, tres bi*en*; the ö is something like German ö, though I think the Lifu ö is more distinctive.

8. In we-pi=10, can you suggest any meaning for pi? No. All I can say is that *pi* goes for five, as *ekete* is four.

9. In tripi=5, what is the tri? I can't tell, unless it has been obtained from the little particle *te* with a harsh or heavy *t* sound almost like *tr*; this *te* is a particle with no translatable meaning; it is a kind of rest or stepping stone from one part of a sentence to another, and is very much used; thus—"Ame la ate kë 'nö, te, troa nyi thupene koi nyën."—"The person who steals shall be punished." It might have been that in counting five on their fingers, as is usual, they might have proceeded—cas, wete, könite, ekete, and then, as they were about to give a more complete number, they made a kind of rest—te, pi—and this in time became tripi; *tri* never occurs elsewhere.

10. In chasi=1 is cha=tsha or $= \chi a$? Ch is pronounced as ch in chapel. We never *write* ch in the Maré or Lifu, only c, which stands for the sound ch. In writing *ch* to you I have committed an error; please adopt the c only, and everywhere.

11. What are the common words for *and* and *the*? Is there any word like the Tongan ko = and?

- i. Maré—ne = and; ko re = the; *ka* is another conjunction for *and*, but the union of the two parts of a sentence, or two words, is not so complete as when *ne* is used.
- ii. Lifu—me and memine = and; la = the; nge in Lifu has the same force as ka in the Maré.

12. In caate = 20 = one mån, what is the simple form of the word man? *ate* is the word for person; trahman = male or man; föe = female or woman.

13. Is 100 = tripi lao ate or tripi las ate? tripi la o ate.

14. Is ceceni pronounced, &c.? Observe remarks on the letter c.

15. Is angeic pronounced ang-e-ic? a-nge-ic.

16. Is ixete (xeje) pronounced with ng for x? No; ixete is Lifu, the x in which is a hard guttural sound, nothing approaching ng; xeje is of the Maré language, the x in which is a much milder guttural sound; a stranger might take it for a g; there is more difficulty in learning the x sound in Maré than the x in the Lifu language.

17. In ziehme, züche is z = Ger. z in zehn; is *h* a hard guttural and ch = tch? The z in these words is the same sound as z in zeal; h is not guttural; but both in Maré and Lifu it is a mere breathing or expulsion of air through the nose immediately before uttering the following m or n; ch should be written c as before remarked, and pronounced as ch in chapel.

18. What are the native words for all, &c.?

i. Maré—ileodene = all; ileethewe = both; acetheden = pair; rewe or rue = couple; ha rewe = double; sese = together.

ii. Lifu—asë, asëjëihë = all; lueje = both; penin = couple; hnaaluen = double; ce = together.

19. What I called *incision* is a custom the natives of the Isle of Pines practised, and consists not in cutting *off* the prepuce, which is circumcision, but in cutting open the prepuce longitudinally, and thereby exposing the glans penis as effectually as by circumcision. I never heard of the mutilation of the penis as practised by some of the tribes of Australia.

7.—GROUP MARRIAGE AND RELATIONSHIP.

By LORIMER FISON, M.A., *Fellow of Queen's College, University of Melbourne.*

In Mr. Edward Westermarck's recent work on "The History of Human Marriage" (Macmillan, 1891) the following passage occurs:—"Most anthropologists who have written on prehistoric customs believe that man lived in a state of promiscuity, or 'communal marriage,' but this hypothesis is essentially unscientific." There is a confusion here between "promiscuity" and "communal marriage." The two things are quite distinct the one from the other, and I shall endeavour in this paper to show what communal

marriage really is, touching as briefly as possible on certain controversial matters which cannot be kept out of the subject.

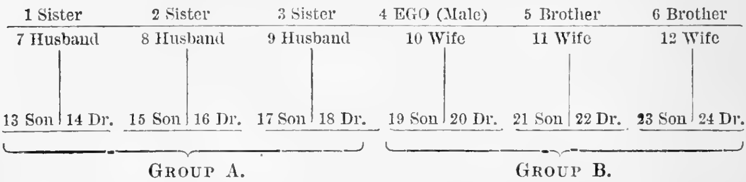
It will clear our way in the beginning if we define our terms. First of all, my friend and fellow-worker Mr. Howitt and myself long ago found it advisable to drop the term "communal marriage" altogether because of its misleading tendency, and to substitute "group marriage" for it.

Then, again, the word "marriage" itself has to be taken in a certain modified sense. It does not mean in this connection all that it means in our own society. It does not necessarily imply actual giving in marriage or cohabitation; what it implies is a marital right, or rather a marital qualification, which comes by birth. Certain groups of males are born with this qualification as regards certain groups of females; every male of a group has the qualification with regard to every female of what we may call the complementary group, subject however, to stringent restrictions which prevent intercourse between individuals who are "too near in blood."

I will now endeavour to show what these groups are, and how they come to be determined. In the year 1866 my deeply lamented friend, the late Hon. Lewis H. Morgan, of Rochester, New York, found among the Iroquois tribes a "system of relationship for the designation and classification of kindred," which he then supposed to be "unique," as well as "extraordinary in its character." Subsequently, to his great surprise, he found precisely the same system among the Ojibwas and other Alongkin tribes. Further investigations, prosecuted with the help of the Smithsonian Institution and the U.S. Government, revealed the same system among the tribes of southern India. I myself, making inquiry for Mr. Morgan (to whom I was then a stranger) at the request of Professor Goldwin Smith, discovered it in the South Seas among the Fijians, Tongans, and other tribes: it was found among many other peoples, and in 1868 the Smithsonian Institution published Mr. Morgan's collected tables of terms of relationship, with his remarks upon them in what has been justly called "a truly magnificent volume," entitled "Systems of Consanguinity and Affinity of the Human Family." The system, thus discovered, in what is called "The Classificatory System of Relationship."

Although, on looking at one of Mr. Morgan's tables—which extend to relationship such as that of "my mother's

mother's mother's sister's daughter's daughter's daughter's daughter—the system appears to be complicated in the extreme; it is nevertheless quite simple, and easy to be understood. The key to it is shown in the following diagram:—



The diagram shows three brothers and their three sisters, with a son and a daughter to each of them.

According to our own system Nos. 21, 22, 23, 24, are first cousins to Nos. 19 and 20, and marriage between them is not prohibited; but the classificatory system makes all these numbers brothers and sisters, and no connubium between them is permitted. No distinction whatever is made between *own* brothers and sisters and what we have called, for the sake of convenience, *tribal* brothers and sisters. Nos. 19 and 20 are own brother and sister, but they are tribal brother and sister to Nos. 21, 22, 23, 24.

So also, according to our system, Nos. 13, 14, 15, and 16 are first cousins to Nos. 17 and 18; but the classificatory system makes them all brothers and sisters.

According to our system Nos. 21, 22, 23, and 24 call No. 4 my uncle, and No. 10 my aunt; but according to the classificatory system they call No. 4 my father, and No. 10 my mother.

So also No. 13, 14, 15, and 16 call No. 3 my mother, and No. 9 my father.

Here then we have two distinct groups, marked on the diagram Group A and Group B, each of which is composed of "tribal brothers and sisters," the individuals being not all of them brothers and sisters according to our own system. If the diagram be continued to the next generation, it will be seen that these groups enlarge, but their construction remains the same to the remotest generation.

Taking now the other relationships, we find that Nos. 13, 14, 15, 16, 17, and 18 address Nos. 4, 5, and 6 by a term which, in Mr. Morgan's tables, is rendered uncle, and Nos. 10, 11, 12 by a term which is rendered aunt; but these terms really mean father-in-law and mother-in-law respectively,

or rather "the father or the mother of a person who is eligible for marriage with me." So also do Nos. 19, 20, 21, 22, 23, and 24 address Nos. 1, 2, 3, and 7, 8, 9.

Hence we see that in these two sets of tribal brothers and sisters we have two distinct intermarrying groups, neither of which can marry within its own bounds. In other words, the groups are exogamous, and they have connubium one with the other.

It must, however, be distinctly understood that, as I said before, there are restrictions which prevent marriage between persons too near in blood. Thus, where 1, 2, and 3 are *own* sisters to 4, 5, and 6, there can be no intermarrying between their children, because, as the natives say, they are "too near;" but when those males and females are only *tribal* brothers and sisters, sufficiently far removed from the direct line, the marriage rite may accrue. The Fijians, for instance, say "They are *veilathini* (brothers and sisters) it is true, but their fraternity is far away."

Mr. J. F. M'Lennan, whose theory was opposed to Mr. Morgan's discovery, accounted for the classificatory system by denying that its terms have anything to do with relationship, and asserting that it is only "a system of addresses." No one but a theorist, determined to stick to his theory, *per fas aut nefas*, could have hit upon such an explanation, and yet it has been adopted by several anthropologists. Setting aside the absurdity, which lies on the very face of it, in the supposition that savage and barbaric tribes in all parts of the world took the trouble to invent so elaborate a system merely for the purpose of addressing one another by its terms, and that independently one of another they all managed to invent the same system, the following considerations are quite enough to refute Mr. M'Lennan's explanation :—

1. If the classificatory terms have nothing to do with relationship, then the tribes who use them have no terms of relationship at all, for they have none other.

2. There are tribes—the Tongans for instance—who have the classificatory system, but who do not use its terms in addressing one another.

3. The terms carry with them all the rights and all the duties which are usually connected with them. Thus there are "tribal brothers and sisters," who are not related at all according to our own system, and yet intercourse between them would be looked upon with abhorrence and punished by death. Can any reasonable man believe that this would

be regarded as a capital offence if the relationship between the parties were not felt to be a real one?

4. The whole system can be shown to be the necessary outcome of the exogamous intermarrying divisions which are found among savage tribes in all parts of the world.

The Groups in Australia.

We may now examine those divisions as they present themselves to us among the Australian aborigines.

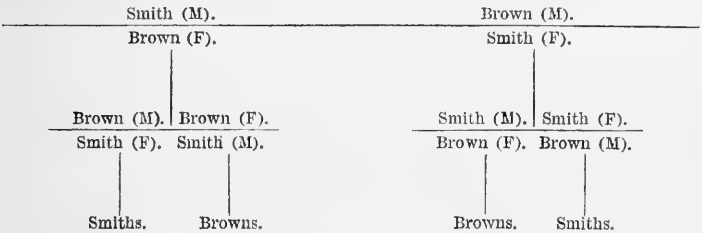
Throughout nearly all the tribes from one end of the continent to the other there run two great intermarrying divisions, each having a distinctive title, which is probably in every case a totem, and which is borne by every one of its members. Every man, for instance, in the Darling River country is either Kilpara or Mukwara—*i.e.*, either Eagle-hawk or Crow—so also is every woman. Among the Kamilaroi,* or Kamilrai, every member of the tribes is either Dilbe or Kupathin. A Dilbe man cannot marry a Dilbe woman; he must go to the Kupathins, every female of whom on his own level in the generation is his possible wife, as far as the primary divisions are concerned, though we shall see by and by that his matrimonial choice is restricted. So also a Kupathin man cannot marry a Kupathin woman; he must get a Dilbe.

This is as if—to put the thing in a familiar form—all the people of Hobart, and indeed of all Tasmania, were made up of Smiths and Browns. No Smith can marry a Smith; no Brown can marry a Brown. Mr. Smith must look out for a Miss Brown; Mr. Brown must go courting to a Miss Smith; but all the Misses Smith are eligible to him, and he may get as many of them as he can; they are all of them his potential wives. Now, if the whole community be thus divided, it is evident that there must be a very large number in each class between whom there is no relationship at all according to our own notions; but the notions of the savage differ from ours, and to him all the young Browns are tribal brothers and sisters, and if young Brown takes to himself any Miss Brown, however remote from him she may seem to us to be, the whole division will be filled with horror, and the two offenders will be put to death, or at all events very severely punished. So real is this relationship to the savage,

* *Kamilaroi.*—This was the Rev. W. Ridley's rendering of the word, but his ear was not to be depended upon for catching the correct sounds of the native words.

that in the Duke of York Island, as the Rev. George Brown informs me, when the two divisions are Pikalaba and Maramara, when a woman has twins, if they be of the same sex they are suffered to live, but if they be a boy and a girl they are killed as soon as they are born as offenders against the exogamous rule. Marriage with the savage is not a contract between two individuals; it is a natural state into which he is born, and therewith he has to be content.

Maternal Descent.—Before we go any farther, it is necessary to point out that in most, though not in all, of the Australian tribes, descent is reckoned through the mother, not through the father, a rule which is of very wide prevalence. The effect of this—still keeping to our homely illustration—may be shown by the following diagram :—(M=male, F=female). The husbands are above the line, their wives below.



Descent being through the mother, Smith's children are Brown's, and Brown's children are Smith's. In the next generation things come round again on the "spear" side, but never on the "spindle" side. It will be seen that Smith's son's children are Smiths, but his daughter's children are Browns.

Now, it must be remembered that the Smith of the diagram represents all the Smith of the same sex and on the same level in a generation; so also Brown represents all the Browns. Each name represents a group—or rather two groups—one male and one female—and the relationships shown in the diagram are taken by every member of the respective groups. It is not that a particular Smith is the husband of a particular Brown, but that all the Smith males on his level are the husbands, or at least the potential husbands, of all the Brown females on the same plane in the generation—that is to say, a group of Smith males is the husband of a group of Brown females, and all the relationships which flow from this view of a marriage come upon the groups in the successive generations. This is what we mean by Group

Marriage, and we need not point out that it is very different from actual promiscuity.

It must be borne in mind that this marriage, as I have already stated, does not necessarily imply actual cohabitation. It is not that all the men of one group actually cohabit with all the women of another group, though even that would not be absolute "promiscuity," but that towards all those women every one of them has a marital right, which may, or may not, be exercised according to other circumstances which have to be taken into account.

These circumstances in actual life place many restrictions upon the man who wants a wife, but nevertheless his right is something more than a mere theoretical one. For instance, in the Cooper's Creek country, if a native visit a tribe other than his own, and his hosts wish to be hospitable, he will be furnished with a temporary wife from a group which corresponds with that which intermarries with his in his own tribe. That this is an established custom is proved by the fact that the natives have signs in their gesture language for an offer of, and a request for that accommodation.

It is evident from this arrangement that, under the two divisions, a man has a marital right over half of the females in the community, but this right is restricted by other regulations. The two primary groups subdivide, their subdivision curtails his right, and other restrictions also come upon him. We may now examine these subdivisions and observe their effect upon the laws of marriage and descent.

The four classes of the Kamilaroi.—Some of Australian subdivisions are peculiar, and at first sight not a little puzzling, in their laws of descent. The Kamilaroi classes, Dilbe and Kupathin, for instance, subdivide as follows:—

Dilbe, into Ipai and Kumbu.
Kupathin, into Muri and Kubai.

The marriage rite is now restricted. Ipai can no longer marry any Kupathin girl to whom he may take a fancy; he must marry a Kupathin-Kubai. Muri can no longer marry any Dilbe girl he likes: he must marry a Dilbe-Kumbu. Hence, we see that a man's choice is now shut up to one-fourth of the girls of his period.

The law of descent is peculiar. Ipai, for instance, marries Kubitha*—that is to say, a woman of the Kubia class—*that*

* The feminine terms take somewhat contracted forms—*e.g.*, Ipaitha contracts into Ipatha; Muritha into Matha; Kumbutha into Butha; Kubaitha into Kubitha.

being the feminine termination. Ipai's children are of the Kupathin class after their mother, but they are not of their mother's sub-class; they take the name of the other sub-class in her division—that is to say, they are not Kubai like their mother, but Muri.

* * * * * * * * *

An Ipai man marries a Kubai girl—their children are Muri. A Kubai man marries an Ipai girl—their children are Kumbu. A Kumbu man marries a Muri girl—their children are Kubai. A Muri man marries a Kumbu girl—their children are Ipai. Or, to use all the names:—

Ipai marries Kubitha—their children are Muri and Matha.

Kumbu marries Matha—their children are Kubai and Kubitha.

Muri marries Butha—their children are Ipai and Ipatha.

Kubai marries Ipatha—their children are Kumbu and Butha.

At the risk of incurring ridicule, I will once more use our homely illustration in order to make this quite clear. Say that the Smiths (= Dilbe) divide into Smythes and Smithsons, answering to Ipai and Kumbu, and the Browns (= Kupathin) into Brownings and Bransons, answering to Muri and Kubai. Then the marriages and descents may be shown by the following diagram:—

SMITH		BROWN	
Smythe (M.)	Smithson (M.)	Browning (M.)	Branson (M.)
Branson (F.)	Browning (F.)	Smithson (F.)	Smythe (F.)
Brownings	Bransons	Smythes	Smithsons

From this it is evident that the law of both marriage and descent remains unaltered as far as the two primary divisions are concerned, excepting that the choice of marriage is restricted. All the children of the Smiths are still Browns after their mothers; all the children of the Browns are still Smiths. But Smythe's children are not Bransons after their mother; they are Brownings; Smithson's children are not Brownings after their mother; they are Bransons; and so also with the other division.

The effect of this curious regulation, whatever its intention may have been, is to put further marital restriction upon those

who are "too near in blood," and the reasonable presumption is that its intention may be inferred from its effect.

The four subdivisions are still further divided into totems, *e.g.*, Emu, Bandicoot, Black Snake, &c., belonging to Dilbe; Kangaroo, Opossum, Iguana, &c., belonging to Kupathin. No man can marry a woman of his own totem, nor of any totem in his own division,* and the child takes the totem of its mother, not of its father. Say, for instance, that Dilbe—Ipai—Emu marries Kupathin—Kubitha—Iguana, his son is Kupathin—Mari—Iguana.

Marriage is still further restricted by local considerations. The tribes are divided locally into what Mr. Howitt and myself have called Hordes for want of a better term, and many of these forbid marriage within their own bounds. This is as if a Hobart Smythe were compelled to go to Launceston for his Miss Branson, and a Launceston Browning had to seek his Miss Smithson in Hobart. And, further, the elders of the tribe would meet in solemn conclave to decide whether there were any bar between him and the lady of his choice, owing to nearness of blood arising out of former marriages, or to blood feud, or any other cause; so that although the range of matrimonial right is a very wide one, the actual fruition of that right may be shut up within quite narrow bounds.

But how often soever the primary divisions may be subdivided, and whatever other restrictions may be placed upon matrimonial choice, it is evident that, as I have said elsewhere,† they consist of certain homogeneous groups; and, taking each group as a unit, it will be seen that the relationships between group and group are precisely those which would arise and continue between individuals among ourselves if marriage were between certain first cousins—between the children of a man and those of his sister—and continued from generation to generation between pairs of their descendants. The groups represented by those cousins are found in many tribes at the present day; the terms of kinship appropriate to them are in constant use; and if, taking the groups as single units, we examine the relationship of any one group to another, we find that the term proper to that degree is used between all the members of the groups. Hence the terms of relationship, as they are now heard in daily use, point out the groups, and the groups,

* We found an exception to this rule in one tribe in New South Wales, but we could not hear of it anywhere else. † Kamilaroi and Kurnai.

taken as units, explain the *raison d'être* of the terms. In these tribes marriage and relationship are conceived, not as between individual and individual, but as between group and group. The group is, in fact, the social unit.

It appears strange to me that, though the existence of the group as the social unit among savage tribes has been so long seen and acknowledged in other matters, it should still be so vehemently denied with regard to marriage and relationship. Land tenure and inheritance are based upon it; it is seen in succession to office where there is hereditary succession, and blood feud proclaims it aloud. If the group be struck anywhere, every member of it feels the stroke, and burns to avenge it. If then it be the group, not the individual, that holds land, that inherits, that is qualified to succeed to office, that strikes and is struck, what difficulty is there in the way of our accepting the fact that it is the group that marries and is given in marriage? And if group marriage be accepted, group relationship follows as a matter of course.

8.—MALEKULA, NEW HEBRIDES.

By REV. T. WATT LEGGATT, *Missionary.*

Birth and Childhood.

After a birth the woman is not allowed to leave the village for 20 days. The child is named by a relative on or about the 30th day. A pig is killed on the occasion, and a distribution of food made. The name is usually that of a relative, and the surname that of the plot of ground on which the child was born.

The mother carries the child astride on her hip, supported by a mat or calico under her arm and over the shoulder. The father frequently carries the child. In fact it is nursed either by the one or other. After a birth the father remains in the house nursing it until the mother is able to go about. The child is lovingly, in fact indulgently treated. There seems to be little or no discipline or training. Suckling is continued for two years at least.

Maturity.

I am unable to give any definite information yet.

Marriage.

Polygamy exists. It is not restricted, but only men of wealth can procure wives in any number.

Children take their classification from their mother, and in war would join her kin. In speaking of the men of a village, natives never forget to tell you the villages to which the different individuals belong.

Widows generally marry again; they are the property of the deceased husband's brother, but he often disposes of them. He adopts the children, if any, and in islands like ours, where population is sparse, children are very much prized.

The work of a married woman consists in planting and looking after the garden. She dare not cook or even touch her husband's food. Women are, as a rule, well treated.

Chieftainship is gained by a man's rising through a long course of degrees, each attained by the slaughter of pigs. This rank is in a sense hereditary, inasmuch as a son takes a high degree at birth, and so starts on a higher platform than the others. Chiefs are called *mulun*, but the name of a high chief is *mara*. Chiefs are all very old men. One of them died lately, and his son, although regarded as chief in his village, has not the same rank as his father had.

Social and Domestic.

The huts are built like a roof placed on the ground. The ridge-pole is supported on two or more forked stakes driven into the ground. For rafters long bamboos are used, which are softened by fire and bent into shape to fit the ridge-pole. It is thatched with the leaves of a kind of palm, sewed on reeds. If well and closely thatched, a hut will stand a long time. Some are standing yet which were built before living memory. The ends are finished with split bamboos.

Cultivation.

Yams, taro, and bananas are grown in well fenced gardens. Yams are ripe in March, and are plentiful until October. Planting begins in September. Thereafter the people live on breadfruit, bananas, and cocoanuts, with whatever yam they have stored in their yam-houses, which are bamboo erections raised four feet or so above ground and substantially thatched. Men and women all work together in the gardens. The whole village goes in turns to put up the fences. They often sleep in their gardens, if they are at any distance from the village.

There is really but one meal cooked in the afternoon, consisting of a pudding of grated yam or taro, toasted yam, breadfruit, bananas, or toasted breadfruit beaten to a pulp, and cocoanut milk poured over it.

Every man has to do his own cooking on his own fire; at least only those of the same name and rank can cook and eat together, as the Baras, the Gulguls, the Muluns, &c.

The women cook for themselves and the children. Pigs are rarely, if ever, killed for food, except when a wild boar is shot. Men will not touch a female pig; it is eaten by women or children. They have fish occasionally, but in no great quantity, as their only means of procuring them is by wading on the reef and shooting at them with bows and arrows.

They give strangers raw food to cook, or, if the same rank, they share the meal of their host.

Ornaments.

The Malekulans usually wear a plume of cock's feathers in their hair, and occasionally decorate themselves with red hibiscus blossoms. They wear small ear-rings of turtle-shell, to which a tuft of hair from a pig's tail is attached. The nose is not perforated; on the arms they often wear bracelets of beads, and, as they have no pockets, they wind a spider's web, of a very strong texture and yellow colour, round their arms, in which they stick a knife or pipe. They often have this same thing tied round their foreheads. Round the neck and legs they tie creepers or dried strips of pandanus leaves.

Painting is common. They smear their faces with black, and their foreheads with a glistening black paint made by burning a cocoa-nut in the fire, the ashes of the shell being mixed with the oil from the kernel. They paint themselves red and white, chiefly for feasts and dances.

Their clothing consists of a belt of cocoa-nut cloth or bark wound round the body. The penis is wrapped in a small mat of a red colour, the end of which is held up by the belt. The women wear a small mat or strip of calico, about 6-ins. wide and a yard long, round them; it passes under the hips and is held up in front by a belt round their middle. Being under the hips, it is quite a covering when they stoop. They wear great quantities of beads, not round the neck but generally over the shoulders and across the chest. They paint themselves black also, like the men, when working, and red for feasts. They have also a habit of smearing their hair with paint and oil for feasts until it looks as if they wore caps.

Food in this district is abundant, and the natives are all plump and well fed.

Wizards.

The native wizards say that the *temeses* appear to men in their sleep and confer magic powers upon them.

They may use their powers for evil, but generally, in the cases I have known, it has been for good, such as for bringing rain.

They are often consulted and paid to lay charms on people to cause death.

In connection with the discovering of causes of death, let me relate the following incident. In the village of Balel or Verelumbon many people were dying, and suspicion fell upon one man, a sacred man, called Mulunevit, that he was causing the deaths. In great wrath, Mulunevit arose and slew a pig, vowing that he was innocent, and sent the carcase of the pig to a bush village called Baruta, ordering them to bring the "Nelimp" to find out the guilty person. This "Nelimp" is a piece of bamboo, 6 to 12-ft. long. Three men are blindfolded and raise it aloft in their hands. They say it begins to pull in a certain direction, and they move on directed by its drawing. At last it leads them to the house of the guilty one and transfixes the thatch. In this case it struck the house of a man in Verelumbon called Ambungtemen, who had to pay two pigs, one to the relatives of the dead and another to the witch-finders. Of course I did not see this, but such is the natives' account.

Death.

Women and children are buried in the bush, a mound is heaped over the grave, and a banana planted in the centre; reeds and branches are also stuck in, and her mats, &c. are hung over them.

As to the burial of men, they are either buried or exposed on a bier in the bush until the flesh decays, and then their bones are buried under a heap of stones in the Batua or burial place. Their huts are left to rot. Sacrifices of pigs are offered at intervals at the grave, and one or two men watch it for a month (30 days), all the while blowing on conches or bamboos at intervals. Gashes are cut on the bodies of mourners, and pigs are sacrificed at the funeral according to the rank of the deceased.

Spirit world is called *Lelemis*, and is somewhere below.

The entrance to it is at a place called *Sinesup*, where a spirit called *Lesivsiv* abides, who seizes the shades as they come up, and with a tomahawk (sio sio) cuts off their noses unless they can show him certain tattoo marks (mostly of lizards). This place is only for those who die a natural death; those who die in war go to a place further north, where "Romberach" treats them in a similar manner.

Lelemis is a poor place, and spirits take rank in it according to the number of pigs they bring with them.

Mythology.

They believe in a supreme Deity, called *Bokoro*, who made earth, sky, and sea, and *formed* men.

Of course their great dread is of the "temes" (verb 3rd sing. of *emis*="to die") who are continually prowling about frightening men. These sometimes, however, come to their wards in sleep and tell them of great events that are happening. One man was roused by his, and sent down to the beach to see a huge rock coming from another island and settling near the shore.

Philology.

Numerals.

1	Bokol.	6	Robokol.
2	Eurua.	7	Rokurua.
3	Entil.	8	Roktel.
4	Embis.	9	Rokbis.
5	Elima.	10	Sangabul.

Pronouns.

Sing.		Dual.	
I......	Anu	1st inclusive......	Anturua.
		1st exclusive ...	Amarua.
thou..	Engco.	2nd	Amurua.
he ...	Hena.	3rd	Arua or Oronrua.

Plural.

1st inclusive	Antil.
1st exclusive......	Amintil.
2nd exclusive ...	Amuntul.
3rd exclusive ...	Hera.

Possessive.

Formed by prefixing "ta," of.

(e.g.)	Mine......	Tukunu.
	Thine......	Tahengco.
	His	Tahena.

Pronomial Suffixes.

1st Verank	my hand.
2nd Veram	your hand.
3rd Verna or vernta...	his hand.

Verb.

Future indicated by affixing "bangcea."
Past indicated by affixing "esu."
e.g. verb to go.

Present.

I go home.........	(Anu)	nepen vere.
Thou go home ...	(Engco)	upene vere.
He go home......	(Hena)	tipene vere.

Singular Future.

I shall go home.........	nepen bangcea vere.
Thou shalt go home ...	upene ,, ,,
He shall go home	tipene ,, ,,
	(or vere bangcea).

Past.

I have gone home.........	nepensu vere.
Thou have gone home ...	upenesu ,,
He have gone home	tipenesu ,,
	(or benesu).

To kill...	tarapse (as above).	
I kill him	(Anu)	netarapse hena.
Thou killest him.	(Engco)	utarapse ,,
He kills him......	(Hena)	tĭtarăpse ,,

Plural.

We (inclusive) kill him.........	Antil tiltarapse hena.
We (exclusive) kill him	Amentil miltarapse hena.
Yea (exclusive) kill him	Amuntul multarapse hena.
They (exclusive) kill him	Hera arapse hena.

Sentences.

Where have you come from? (The only greeting we have)	Be nembe.
Where are you going?	Abukambe.
What do you want?	Maps nepach.
The fighting is ended.	Nabura mokot. (broken).
The sun shines.	Niel tĭsin.
The moon shines.	Ambisia timier.
I shall go to Pangkumu to-morrow.	Anu nepen buku Pagkumu mebho bagcea.

Tell the men to make the fence on the day after to-morrow.	Ubtene asamangk aramucea nambungko weisa bagcea.
Thou shall not steal.	Siki ulevea binoke.
Who told you?	Hase tibtene engco.
Let us go and spear turtle.	Antil tilpene tilsare nevea.

List of Words.

Man	Asamangk.
Woman	Tambaluk.
Head	Batina.
Hair of head.........	Nepolin batina.
Eye	Metina.
Nose	Ngunsend.
Tongue	Lemen.
Ear	Arsina.
Hand	Verna.
Thumb	Busembus tilumbon.
Foot	Neluan.
Bone	Bolongkont.
Blood	Inrim.
Fire	Nachamp.
Water	Nabui.
(Sea	Netis.)
Sun	Niel.
Moon	Ambisia.
Father	Teta or Temen.
Mother	Nina.
Son..............	Netin tamare.
Daughter	Netin tambaluk.
Brother	Yeye (elder brother) Atisina.
Sister	Rabina.
Cousin	Sister or brother (often). (Nalum).
Uncle	Apapa.
Aunt	Nina.

Verbs.

Give	Levesak.
Take	Levea.
Make or do	Mucea.
Bear (*i.e.* carry)......	Ing unta.
See	Lise.
Hear	Euronga.

Additional information about the natives of Malekula, New Hebrides: T. Watt Leggatt, Missionary :—

Birth and Childhood.

The natives of Port Sandwich bind the head of the child with ropes of plaited bark to elongate the head. This is not done any further north.

Suckling is continued for about three years.

Abortion is often practised by the women, as they do not wish to be troubled with the rearing of children; it is also caused by carrying heavy loads, climbing cocoanut trees, or eating certain herbs.

I know of only one case of *infanticide.* A woman gave birth to a female child and immediately buried it under the floor of her hut. She had sons previously, but this was her first daughter.

As far as I can learn, there is no such thing as *betrothal.* Girls are married when about six or eight years of age.

Circumcision is performed usually when the boy is from three to five years of age. I have, however, seen some boys of 15 or 16, from inland tribes, not circumcised. Until circumcision takes place they run naked; even those lads were absolutely nude.

I have not seen circumcision performed, but the natives describe it as follows:—The boy is laid on a mat and held down by some men, while one with a sharp bamboo makes a slit downwards in the foreskin, and then cuts it round. There is no special operator, any man may do it. The operator is presented with a mat, and a huge pudding of yam or bananas (nelougk) is made for the others. The boy is kept in the "amil" or men's house for 10 days, and his food brought to him. He is not allowed to see women, or women to see him during that time. When he has recovered, the penis is wrapped in a strip of banana leaf, which is doubled over a little belt and so held up. It is somewhat difficult to get reasons for anything from natives: that their fathers, *asimagk tui,* "the men of old," did so, seems to be quite sufficient for them. Down in the southern islands they say that if circumcision is not done, the lads will not grow tall and strong. Here they seem to say that it is a *sine qua non* to marriage.

I am not sufficiently acquainted with their ceremonies of initiation to be able to describe them. Even after circumcision there seems to be little restriction placed on the boys. They

continue to live and eat with their mothers, but when they become " Baras," then they are separated, and must prepare their own food on their own fires.

Rank or Degrees.

To give a full description of these would be a long labour. There are four classes through which men rise—Baras, Gulguls, Muluns Mals, or Maras. No one of these classes can eat food with any of the others, or cook it on the same fire, and of course none of them can eat food prepared by a woman, or on a fire kindled or used by her. In cases of sickness, women may prepare food for their husbands, or brothers, or sons, but when the man recovers he has to kill a pig to regain his footing.

To become a Bara, or rise to any of the other degrees, a man makes a " Mangkea " or " Sing-sing " at which he sets up a *temes*, a carved and painted fern tree, to represent one of his ancestors, kills from two to ten pigs, and assumes his new name.

After that a Bara is reckoned among the men, sits in their *amil*, goes out to fight with them, may marry, and in general has all the privileges of the tribe.

Marriage.

When a man has a marriageable daughter, he travels round the villages or sends word that he is disposed to treat with any one about her. For a young girl 9 boars and 2 pigs are demanded, but less for a widow.

As I remarked before, there does not seem to be any betrothal; any man who can muster the pigs may have the woman, and one reason they give for marrying their girls at such an early age is to prevent others from violating them. There are degrees of consanguinity which may not marry; *e.g.*, brothers and sisters, which is a very wide term, embracing—1. Actual brothers and sisters. 2. Cousins german.

On the marriage day the little bride is adorned, her face painted black and red, a new mat tied round her middle, and a longer one, about 9 feet, tied round her shoulders containing her few possessions, knife, &c. She is escorted by all the women of her village, some of them carrying branches of dracaena, having the leaves tied with a root. The men generally follow at a short distance. On their arrival at the husband's village, the father addresses the bridegroom, tells him that he must not beat her, or desert her, but see that

she has food and shelter. On his promising to that effect the pigs are handed over, and the women take the food, yams, &c. he has provided, and return home.

Polygamy is practised, but not very largely. It is not restricted.

Children follow the mother's kin, and take the side of her tribe in war, even although they may live in another village.

Brothers and sisters are very chaste in their intercourse. Any violation of this, or intercourse with unclean women is supposed to be punished by the man becoming afflicted with a sort of *gravel* (meme menrikenrik), a dribbling of wind.

A married woman has the heavy share of the work—the preparing of plantations and the cultivation of food. She also carries all the food and firewood, and carries all the loads of food for barter to different villages. Women are not cruelly used; how they fare depends on their own exertions in cultivation, gathering shell-fish, and cooking. They can take food and come to the trader to get calico or matches for their own use. They also prepare mats and thatch for the houses.

The husbands are very jealous and suspicious. No woman here goes inside a trader's fence, because he is unmarried, nor would they approach the house of the celibate Roman Catholic clergy who resided here for a time. They come about us quite freely, because of my wife's presence.

The Tribe.

The tribe with us is really the village or collection of villages adjoining each other.

There is generally one chief. His position is to some extent hereditary, but the son does not always succeed to his father's rank; *e.g.*, Maramulamut, the high chief of Asang, died and was succeeded by his son Mulan who, however, must make the necessary Mangkeas before he can become a *Mara* like his father. In this case, as he is a worthless, lazy fellow, it is not likely that he will succeed. Chiefs' sons rise more quickly through the grades than others, as their fathers are able to provide the necessary pigs.

There seems to be no council, except that the men discuss all matters.

Social and Domestic.

I think I described them fully in a former paper.

Wizards.

These act somewhat after the style of spiritualists. They have their controlling spirits or "temes" (*temes* from *emis*, to die=a dead man, or rather his ghost).

They consult these. They obtain their powers from the *temes* visiting them in their sleep and revealing secrets to them. Their powers are used malevolently as a rule, although they often endeavour to cure the sick, and bring rain or favourable winds. Women as well have communication with spirits.

Death.

The great cause of death is "embake." Those who speak English call that poison, but they really mean witchcraft or the evil eye. Sometimes women cut each other for mourning, but that is not common. Women are buried in the bush; a mound is heaped over the grave, and their little mats are hung on branches stuck into it. When children die the father often ties some little possession, a turtle-shell bracelet, &c., round his neck which he wears for years.

After the death of a man of rank, all the men have their faces blackened for a month. The dead are wrapped up in mats, being first painted and dressed as in life. A cocoanut leaf is plaited into a basket, into which the corpse is put, and a pole thrust through it lengthwise for carrying.

A little to the north of us, the bodies of chiefs are exposed on a bier in the bush until the flesh decays, but with us they are buried in a shallow grave, covered with a few cocoanut leaves and a little earth until decay takes place, after which the bones and skull are placed in the *batua* or sacred ground, among a pile of stones.

As men are buried near the *amil*, people watch these for 30 days, and during the night blow a long bamboo flute at intervals.

This flute is called *metiorior*, from metior="to weep," *i.e.*, let tears flow. (Autang=is to wail). It has a very wailing sound. After a death, a pig is usually burned at the side of the house, and food is burned at the grave several times after. The widow of a high chief must not leave the village for a year after his death, neither is she allowed to wash, or cut her hair, which hangs in matted, greasy clots.

Mythology.

They believe in a Supreme Being called *Bokor*, who they

say *kneaded* the first man and woman out of clay, a somewhat remarkable similarity to the narrative of the Creation in Genesis. This would seem to make Bokor a supreme universal deity, but some of their other stories represent him as *local*, in fact only as a great chief living among men and taking a keen interest in human affairs and amusements. On this reef opposite our house there is a stone, about 8 feet high, called Nevit Penepen, "the walking-stone." This boulder, long ago, was on the top of a hill some miles inland; Bokor lived there with his son, a young boy. There was a hollow behind the house at some distance in which his water had formed a considerable lake. One day Bokor went to a Mangkea at some distance, leaving his son to make a pudding; he did so, and after his work was over strolled out and discovered this lake; on tasting it he fancied that it was salt water (netis), and that it would be good flavouring for the pudding; accordingly, he poured some over it. Bokor returned and began to eat it, but having tasted it he demanded where he got the water; on the boy telling him, he went out and dashed down the side of the lake with his foot, which broke down the valley, carrying houses and everything before it, and this boulder with the rest.

Their story as to the origin of fire is that a woman and her little boy were out in the bush, and he began to cry and refused to eat the raw food. She tried to amuse him by rubbing a stick on a piece of dry wood, and was astonished to see it smoke and smoulder and at last break into flame. She laid the food on this and found it much better. After this, all began to use fire.

9.—ANEITYUM, NEW HEBRIDES.

By REV. J. LAWRIE.

Birth and Childhood.

THERE is much rejoicing at the birth of a boy, but comparative silence at the birth of a girl. When the islanders were heathen, infanticide of female children occasionally took place by simply leaving them to die in the bush. The nearest male relative has the privilege of naming the child, if a boy, and the same with the nearest female relative, if the child is a girl. The child is suckled for about two years. A feast of

food is usually given when the child (especially if a boy) is weaned. Deformed or sickly children are just allowed to grow up as best they may; nothing special is done to them, or for them. Mother carries the child on her side, across the haunches. Children are not, as a rule, well disciplined by their parents, but Christian parents try to teach their children to read the scriptures. Female children are not *now* betrothed when young.

Maturity.

Females are mature at about 14 years of age, males from 16 to 18 years.

Circumcision

Is not now practised on Aneityum, but in former times the ceremony was performed by the man or sorcerer whose office it was by hereditary right. It was done when the lad was from seven to ten years of age, with a bamboo knife. It was said by the natives to increase the stature and improve the physique of the individual. Food was always cooked by others and brought to the lad during recovery, which might be from one to three months. On complete recovery a special fowl, lobster, or other fish was cooked and given to the lad to eat. On this being received he was welcomed into the tribe with great shouting and rejoicing—and had afterwards the privilege of wearing his private member in a pocket or wrapper of grass or other prepared material, whereas before that he went about completely nude.

Marriage

Is usually arranged for by chiefs or heads of tribes. The girl does not pass into charge of the husband until she reaches maturity (or puberty). A feast is made when the formal marriage takes place. They usually married within the tribe, although not in blood relationship, yet the children of a brother and sister may marry, while the children of two sisters were looked on as brothers and sisters. Polygamy was common in pre-christian days. In war, the tribes acted in a body and had a common interest. Leading coast headlands usually divided the island into districts, of which there were six, each governed by a high chief; also two inland chiefs, who were in some measure subsidiary to the shore chiefs—these were often at war with each other. Widows were always strangled by the son, if old enough, or the nearest relative. The widows wished this, as they would, if

allowed to live, have been disgraced and chided by the dead man's friends; also the belief that they would live together hereafter.

In heathen days the wife was to all intents and purposes the slave of the husband: the words for wife, slave, or servant are interchangeable.

Children inherited parents' land equally, according to common consent. Orphans are cared for by uncles or aunts. Married women help in plantation work and cooking the food, &c.

The Tribe (partly answered in last).

The office of chief is hereditary; it passes from father to son, or nephew or nearest male relative; only on rare occasions have there been female chiefs. A chief was frequently a supposed disease-maker, and therefore feared and obeyed in matters relating to food and war. The tribal council consisted of the head men of each village or hamlet under the jurisdiction of each high chief. All infractions of tribal law were discussed, and punished by the arms being bound and the culprit left for several hours to the public gaze, also by his getting growing food uprooted to feed the council; but in heathen days club law was the rule rather than the exception. Quarrels about land and women were the leading causes of offence.

Social and Domestic.

Natural bent posts are put in the ground and made to meet over a ridgepole at the top, then bound together by means of vines, closed all round except at one end, which serves as door, window, and chimney. The hut is covered with thatch made from sugar-cane leaves sown on to long reeds, or thatch in some cases made by plaiting cocoanut leaves, and then covering with long reeds, with the grassy ends hanging over.

Ground is cultivated with digging stick or iron crowbar four feet long, and all the earth pulverised by hand. Taro is plentiful, and is grown in swampy land; yams are less plentiful, and are grown in soft soil; bananas, sugar-cane, breadfruit, and chestnuts are plentiful. Food is usually cooked in earth ovens by means of heated stones.

In pre-christian days the corded hair and ear ornaments were the same as on Tanna. Women were always well clothed by means of pandanus leaf skirts, even when heathen.

Wizards.

The power of the sorcerer is supposed to descend from father to son in the same family. He was supposed to obtain his magic power by constant devotion to the service of the gods or "Natmases;" these were unseen spirits. These men were held in great fear and veneration by the native community; their power was equally on the side of good and evil, by bringing rain or driving it away, or by causing sickness or driving sickness away; also supposed to have the remarkable power of making thunder and lightning, causing hurricanes, &c., also of making the different kinds of food to grow, as well as giving or withholding the fish in the sea. These men used to prepare (and also eat) the greater portion of the food given by the natives to propitiate the spirits or "Natmases."

Another class prepared sacred earth for young men wherewith to bewitch young women whom they wished to seduce. This was composed of a piece of wood, a piece of banana leaf, and a lizard, burnt to charcoal and put into a section of bamboo, to be kept till wanted.

Death.

In nearly all cases of the death of leading men the cause of death was set down to sorcery by the burning of some remains of food of which the deceased had eaten (called "nehken"), such as the skin of a banana or the chewings of sugar cane. This was, as a rule, carefully kept by the eater until he got the opportunity of burning it himself, lest an enemy should get it and carry it to the disease-maker or sacred-man. In heathen days the dead body was decorated with strips of native cloth tied round the body to bind the arms and legs; a stone was tied to the feet, and, after the face had been painted with red clay, the body was carried to the edge of the reef and thrown into the sea. Only the highest chiefs were buried on land; in that case the head was left above ground, and female mourners watched the body until the skin, &c. on skull was decomposed, which was duly kept in a cave or in the sacred grove. During this time the spirit of the chief was fed by small quantities of food being placed in a basket and hung on a branch of some tree near by. In ordinary cases of burying in the sea a fire was lit on the beach so that the spirit of the departed might come and warm himself if he felt so inclined.

A case was recorded of a savage who killed, cooked, and ate his own child, so depraved had the people become. Men killed in war were always cooked and eaten. Cannibalism was a common practice.

Spirit World.

Many *Natmases* or spirits were worshipped; these were appealed to and propitiated by small offerings of food, hung in small baskets on the branches of trees or laid on the top of sacred stones where certain of these spirits were supposed to have their habitation. Departed chiefs were named in their appeals or prayers for rain, &c., but the great spirit or *Natmas* was Inhugaraig; he was most feared, and common people scarcely dared pronounce the name audibly. The tradition is that this great *Natmas* went out to sea to fish on the leaf of a tree which grows here, having no mid-rib, called by the natives "Nesiaig," his fish hook got entangled, and on drawing in his line he found a mountain peak attached to the hook. He sat thereon, and drew up the whole island, and afterwads set man there, which, as far as can be learned, are the progenitors of the present inhabitants.

May this not have some connection with the story of the Flood and the receding of the waters? The sun and moon were considered to be husband and wife, and the moon was especially honoured by offerings of food, also by songs and dances in her praise. There was another class of spirits called *Inpotheth*; these were a set of mischievous imps, or, as I suppose, shadows of branches cast on the path on moonlight nights; these take the place of ghosts in British phraseology. The stone idols which were said to be inhabited by the spirits were unhewn, usually of a round or oval shape, with a smooth waterworn surface as if picked up on the beach or in the brooks; others were rude, rough, and large stones mostly without any carving. The entrance to the spirit world was the crater of an extinct volcano at the western extremity of the island, in the direction of the sunsetting. Their heaven, or good place of after-abode, was a sensual feast, with plenty of food to eat; their hell, or bad place of after-abode, was a scanty supply of bad food of the most loathsome description. The good and bad people were the liberal and the mean contributors of food at feasts, in honour of the Natmases.

"Inhugaraig" did not actually create the island, but he found it. In the order of Natmases, or spirits, he seems to

have been the special "Sun" god, as implied by his other name "Nagesegaaretha." "Moitikitiki" was the great rain god. All the elements in the heavens, the foods on earth, and the ills the human body is heir to had their special Natmases, and these spirits were represented by rude uncarved sacred stones, the more important ones only being in the possession of the specially sacred men. These spirits were said to have the power of both helping and injuring men, also of keeping back or bringing disease; to them was also ascribed the power of giving success in war; failure or misfortune implied the displeasure of the Natmas towards the individual or tribe by a non-compliance with some rule, or a stingy contribution of food to some feast; hence the poor natives were living in fear and bondage all their days.

Philology.

Numerals.

Ethi	one.
Ero	two.
Eseij	three.
Emanowan.........	four.
Ekman	five.

The fifth number is turned into "nekman," which means a whole hand, then the sixth number is expressed by the phrase a hand and one = seven, a hand and two = eight, and so on to two hands and a toe = eleven, up to two hands, a foot and a toe = sixteen, when twenty is reached a greater number is expressed by an indefinite phrase as "many," "a great many," "a very great many." Now-a-days the English numerals are known and used by the Aneityamese.

Nouns, with exceedingly few exceptions, begin with N. or In; the plural of these nouns are usually expressed by dropping the *n* or *in*.

The personal pronouns have four numbers, namely, singular, dual, trial, plural. The first person of the dual, the trial, and the plural has also an *inclusive* and *exclusive* form. The masculine and feminine gender of the personal pronouns are the same.

Nominative, Singular.

1	Ainyak.........	I.
2	Aiek............	Thou or you.
3	Aien............	He or she.

Dual.

1	Akaijan.....	We two (inclusive) you and I.
	Aijumran...	We two (exclusive) he or she and I.
2	Aijanran ...	You two.
3	Aran.........	They two.

Trial.

1	Akataij......	We three (inclusive) you two and I.
	Aijumtaij...	We three (exclusive) they two and I.
2	Aijantaij ...	You three.
3	Ahtaij	They three.

Plural (including four and upwards).

1	Akaija	We all (inclusive).
	Aijama......	We all (exclusive).
2	Aijana.......	You all (you four or more).
3	Ara	They all.

Objective, Singular.

1	Nyak......	Me.
2	Euc	Thee or you.
3	Yin	Him or her.

Objective, Plural.

1	Caija......	Us all (inclusive).
	Caina ...	Us all (exclusive).
2	Cana......	You all.
3	Ra.........	Them all.

Possessive, Singular.

1	Unyak......	My or mine.
2	Unyum	Thy or thine or yours.
3	Oun	His or hers.

Plural.

1	Uja.........	Our (inclusive).
	Unyima...	Our (exclusive).
2	Unyimia...	Your.
3	Ura.........	Their.

Dual.

1	Intan atga akaijan	We two walk (inclusive).
	Ecran atga aijumran	We two walk (exclusive).
2	Ekan atga aijauran......	You two walk.
3	Eran atga aran............	They two walk.

Trial.

1	Ehtaij atga akataij	We three walk (inclusive).
	Ehtaij atga aijumtaij	We three walk (exclusive).

2	Ehtaij atga aijantaij......	You three walk.
3	Ehtaij atga ahtaij	They three walk.

The possessive pronoun is often an affix to a noun, as—

1	Etma-k......	My father.
2	Etma-m.....	Thy father.
3	Etma-n......	His or her father.
1	Nikma-k....	My hand.
2	Nikma-m ...	Thy hand.
3	Nikma-n....	His or her hand.

The verb has three tenses—present, past, future. The pronoun follows the verb.

Singular.

1	Ek atga ainyak.........	I walk.
2	Na atga aiek	You walk.
3	Et atga aien	He or she walks.

Plural.

1	Inter atga akaija	We walk (inclusive).
	Ecra atga aijama	We walk (exclusive).
2	Eka atga aijana.........	You walk.
3	Era atga ara	They walk.

Same with—

Ek apan ainyak.........	I go.
Na apan aiek............	You went.
Et apan aien	He or she went.

Past Tense, Singular.

1	Kis atga ainyak	I walked.
2	As atga aiek	You walked.
3	Is atga aien	He or she walked.

Plural.

1	Intis atga akaija.........	We walked (inclusive).
	Ecris atga aijama	We walked (exclusive).
2	Akis atga aijana.........	You walked.
3	Eris atga ara............	They walked.

Future Tense, Singular.

1	Ekpu atga amyak	I will walk.
2	Napu atga aiek	You will walk.
3	Etpu atga aien............	He or she will walk.

Imperative Mood, Singular.

1	Ekmu atga ainyak	Let me walk, or I will walk.
2	Namu atga aiek	Walk thou.
3	Etmu atga aien	Let him walk.

Present Tense.

1	Ek atgei yin ainyak......	I kill him.
2	Na atgei yin aiek.........	You kill him.
3	Et atgei yin aien	He kills him.

Past Tense.

1	Kis atgei yin	I killed kim.
2	As atgei yin...............	You killed him.
3	Is atgei yin	He killed him.

Man	Natimi.
Woman	Intakita.
Head (his head)	Nithjin in.
(my head)............	Nithjinik.
Hair of head	Numri nithjinin.
Eye (his eye)	Nesganimtan.
(my eye)................	Nesganimtak.
Nose	Inginthjin.
Tongue.........................	Naman.
Ear (his ear)	Intikgan.
Hand (his hand)	Nikman.
Thumb.........................	Nupsikman nimeth. (the elder finger).
Foot (his foot)	Nethoon.
Bones	Niji ethoon.
Blood	Injairan.
Fire	Incop.
Water	Inwai.
Sun	Nagesega.
Moon	Inmohoa.
Father (my father)	Etmak.
Mother (my mother)	Risek.
Son	Inhal oun (atamaig).
Daughter	Inhal oun (atahaig).
Brother (my)	Etoak or Etwak.
Sister (my)	Natahaigirak.
Cousin	Inraimu.
Uncle	Matan.
Aunt............................	Risen (same as mother).

The Verbs.

Give (me).......................	Alupai (nyak).
Take (you)	Leh (aiek).
Make or do	Ago.
Bear	Apos.

Burn............................	Cas (or to burn Atnamuth).
See	Almoi.
Hear............................	Atahaijaig.

Simple Sentence.

Ak Dr. Fraser, Ekaihenc vai encainyak um ika etmu acis yi alwai nauritai unyum a Jehovah va nimaihpas yin.	Dear Dr. Fraser, I compassionate you, and express the desire that Jehovah may bless your labours to his own glory.

10.—THE NAIR POLYANDRY AND THE DIERI PIRAURU.

By LORIMER FISON, M.A., *Fellow of Queen's College, University of Melbourne.*

Mr. J. F. M'Lennan, who has a considerable number of followers, treats marriage by capture as an actual *system* of marriage among early tribes, and Polyandry as a large factor in ancient society. The former of these has nothing really to do with polyandry, but the two are so involved in Mr. M'Lennan's argument that it may be as well to clear it out of our way. The practice of Exogamy, he says—*i.e.*, the rule forbidding marriage within certain limits—compelled men to go outside their tribes for their wives; and, as "the relations of separate tribes in a rude state of society are uniformly, or almost uniformly hostile," the only way in which men could get wives was by capturing them. Capture, therefore, was "the necessary preliminary to marriage." Polyandry, Mr. M'Lennan says, arose from the practice of female infanticide, "which rendered women scarce." These statements appear to me to be altogether mistaken, for the following reasons :—

1. In the first place, exogamy does not compel men to go to hostile tribes for their wives. Savage people, as a general rule, are made up of exogamous divisions, but the divisions intermarry one with another, and a man has no need to go to an enemy's camp for a wife. He will kill his enemy if he can, and capture his wives, but he is not driven to the act by an impossibility of getting a wife from among his own people.

2. In the second place, if Mr. M'Lennan's theory were correct, each tribe would have to capture all the women of the other, and its own women would have to be all captured by the other tribe; which, as Euklid says, is absurd. Never-

theless it is absolutely necessary to the theory, which is that exogamy forbids marriage within the community, and that the only way of getting a wife is by capture from another community. If, therefore, any girls on either side are left uncaptured, what is to be done with them?

3. In the third place, as a matter of fact, savages do not practise female infanticide—that is to say, they do not kill female children rather than males. The Hindu, who has succession through males, and who depends on his sons for feeding him with sacrifices when he has taken up his abode in the next world, and who has to give a dower with his daughter, will kill a female infant rather than a male, if he practise infanticide at all; but not so the savage, whose descent is through females, and who receives payment from the young fellow who wants his daughter.

4. And, in the fourth place, no tribe on the face of the earth ever had polyandry—or polygynia either—as its *system* of marriage. Cases of polyandry are to be found in plenty of tribes, and everybody knows that the other form of polygamy—plurality of wives—is frequent enough; but *as a complete system of marriage*, it is an arithmetical impossibility. It requires a disparity in number between the sexes such as never existed in any normal community. Polyandry, of course, means that every woman has several husbands. I say "*every* woman," because every woman must be reckoned. Savage society has no old maids in it. Then if the average number of husbands to each woman be the lowest possible to constitute polyandry—that is two—the men must be twice as numerous as the women, which again is absurd.

The same argument is fatal to the other form of polygamy *as a general system of marriage* in any community. It is only the powerful chiefs, and the men rich enough to buy, who have a plurality of wives, and not more than one apiece falls to the lot of the commoners. Everyone who has lived among savage tribes will confirm this statement.

But further, the evidence for polyandry is not at all satisfactory. Even the special case on which Mr. M'Lennan mainly relies—that of the Nairs—can be shown to be not polyandry at all, but group-marriage; and the main object of this paper is to examine the so-called Nair polyandry in the light of a precisely similar Australian example.

The account of the Nair custom, as given by Mr. M'Lennan from various authorities, is that "among the Nairs it is the custom for one woman to have attached to her two

males, or four, or perhaps more, and that they cohabit according to rules." Each man, however, "may be one in several combinations of women—that is, he may have any number of wives."—(Studies in Ancient History, p. 100, new edition, 1886.) Now let us turn to the Pirauru custom, found among the Dieri of Cooper's Creek, and see how it looks beside that of the Nairs.

Among the Dieri every woman has a certain man who is her *special* husband. He is her *noa*, and she is his *noa*. But, in addition to him, she has a number of "accessory husbands" (to use Mr. Howitt's convenient term), and these are called her Piraurus. They are *pirauru* to her, and she is *pirauru* to them. They must always be of a division which is marriageable to hers—that is to say, as in the case of the Nairs, the selection is "under certain restrictions as to caste."

So far, we have a state of things which is shown by the following diagram. To avoid crowding it, I give only two "accessory husbands," but the woman may have more of them. (M = male, F = female.)

$$M_1 \overset{\text{Noa}}{\rule[0.5ex]{6em}{0.4pt}} F_1 \left\{ \begin{array}{l} \text{Pirauru } M_2 \\ \quad\;\;\text{,,} \quad\;\; M_3 \end{array} \right.$$

Here we have a woman, F_1, with her Noa, M_1, and her two Piraurus, M_2, M_3. This woman, then, has three men, any one of whom may lawfully treat her as his wife. If her Noa and her Piraurus are all in the camp together, the right of the Noa overrides that of the Pirauru; but if the Noa be absent, or if he choose to make other arrangements, one of the Piraurus can take her. This looks like polyandry, pure and simple, and no one could blame an observer for so recording it.

But now let us go a little further. M_2 and M_3 also have Noas of their own, and each of these women may be Pirauru to the other men. Our diagram now becomes enlarged, as follows:—

$$\begin{array}{l}
M_1 \overset{\text{Noa}}{\rule[0.5ex]{6em}{0.4pt}} F_1 \left\{ \begin{array}{l} F_2 \\ F_3 \end{array} \right. \\[1ex]
M_2 \rule[0.5ex]{6em}{0.4pt} F_2 \left\{ \begin{array}{l} F_1 \\ F_3 \end{array} \right. \\[1ex]
M_3 \rule[0.5ex]{6em}{0.4pt} F_3 \left\{ \begin{array}{l} F_1 \\ F_2 \end{array} \right.
\end{array}$$

Here we have a group of males cohabiting, under certain definite regulations, with a group of females; and, since

each male and each female may have other Piraurus, each of whom has his or her Noa, the group may extend to considerable dimensions. This is precisely the Nair custom, and it is not polyandry at all in Mr. M'Lennan's sense of the term. It is regulated Group-marriage. I say "regulated," because neither men nor women can choose their Piraurus at their own will. They are allotted by the Council of Elders, having regard to the regulations of the inter-marrying divisions of the tribe, and to other circumstances which may have to be taken into consideration.

I had better state, in conclusion, that this Pirauru custom is not common to all the Australian tribes.

11.—EFATE, NEW HEBRIDES.

By REV. D. MACDONALD.

Birth and Childhood.

On the day of the birth of a child a number of women assemble, and one old woman called the Mitamauri, or Matemaure, has charge of the proceedings. She takes the leaves of a plant used in ceremonial or religious purification called *nasuafa*, and performs an operation called *koro* on its leaves, that is, she makes a prayer or incantation, which is finished by breathing several times upon the leaves. Then the assembled women attach these leaves to their waist cinctures, and are not allowed to *surata*, that is, to go away from that house about their ordinary business till after the performance of another ceremony on the fifth day after the birth, when they remove the leaves of the *nasuafa* from their waist cinctures. The ceremony on the fifth day is the *koroing* of the *noas* (native cabbage) leaves, which are then cooked and given to the mother of the child for the first time to be eaten. When it is known that the child is a male some man in the village raises the cry used by men only. This is regarded as the expression of a wish that the child may, when he grows up, be a man indeed; if a female, he raises the peculiar shrill sounds made by women in laughing—as before, expressing a wish that the child may grow up to be a perfect woman. On the 30th day, when the child is to be taken out of the house to the shore, if it is a female, one goes before with a small *nala* (female carrying basket) and *intei* (red powder, tumeric), and paints or marks any objects

on the way with the *intei*, and finally hangs up the *nala* and *intei* on the shore ; if a male, a bow is thus hung up and left instead of the *nala*. On all these occasions there is a feast. The woman is isolated and regarded as unclean till the thirtieth day, on which day, for the first time, the mother and the child go out of the house and are both purified with *sea water*. According to Efatese notions the *sea* is the great purifying medium. This particular purification on the thirtieth day of the child is called *naselian* ; they *selia ki* the child ; as to the mother, she is said to *los*, *i.e.*, wash or bathe in the sea, or in sea water. The child is washed in sea water in a vessel, in which also gravel is put. This completed, a great shout is raised, and the *Matemauri* is dismissed with presents or payment for her services.

The name in Efatese for *uncleanness* is *nimàm* (dialect, *namàfu*), and that of childbirth is called *nimam nafiselan*. The men are afraid of it, and keep away from the house in which the birth has taken place. They say that men by going to or near the house would contract the *nimam* or uncleanness, and that in consequence "their eyes would be darkened (that is, they would be weak) in war," and that if, having contracted it, they went to their plantations, the yams would rot, *boa*, *i.e.* literally, stink. This applies to the day of birth. A sacred man (*natamole tabu*), who inadvertently goes near such a house, immediately purifies himself by a religious ceremony, as the uncleanness would be fatal to his sacredness or holiness (*natabuen*).

With respect to infanticide, if the child was born and the parents wished it killed it would be buried alive. Deformed newly-born infants were treated in this way. No cannibalism accompanied this practice, though a feast was held. Abortion was much practised. Violence was applied to the child in the womb either by the mother by the *matemauri*, this latter accompanying the manipulation with the *koro*. A plant called *nakasu tabu* was sometimes eaten by a woman who had just given birth to a child, in order that she might not again conceive while bringing up the child born. Various reasons are given for the general practice of infanticide, which may be summed up thus: to avoid the necessity of self-denial, expense, and trouble.

The child is named by a fixed rule, as follows:—The name consisted of two parts, the tribal prefix denoting the tribe of the father, and a general term which was often suggested by the circumstances of the time of birth, or by its being borne

by a relative. Any one hearing the name of a child, male or female, at once knows the tribe (*nakainaga*) of its father. Thus let the child's name be *Turi tamate—tamate* means peace, and *Turi* denotes that the father of the child is of the *Nakainaga naui* (yam tribe). *Tamate* (a very common name) may be given, and no doubt originally was given, because peace was prevailing at the time of birth. *Turi naru* (*naru*, "war," literally "arms") is another example, the child having been born in time of war. And so all children have names given to them, of which the first part denotes the tribe of their father. The native expression is "the yam tribe *bisi* (begets) *Turi*," the naroa tribe *bisi Mako*," &c.

The mother carries the child on her back, slung in a fine mat made for the purpose; the father carries it in his arms. Suckling is continued two or three years. Nothing is applied to the child's head to regulate its shape. The child is lovingly cared for in infancy by its mother. Later, when a boy, he does very much as he likes, and as he belongs to his mother's tribe, and not to his father's, it is his mother's full brother, his maternal uncle, who has to instruct him. Such a boy going much with his father is often spoken to thus:—What do you mean by going with another (meaning his father)? Go with your *lolo* (*aloana*—his uncle) that you may learn from him.

Maturity.

No certain age can be mentioned as that at which either boys or girls reach maturity. As to circumcision it was not much practised in Efate, but more in the Shepherd Islets. It was performed with a bamboo knife by anyone who could do it. So far as I can learn, the reason for the practice was, that the boy might grow big and well proportioned. When they saw a boy lanky and ill looking, they would say, "Let us circumcise him that he may grow well and fill out." And they say that pigs, when cut, grow fat and fill out in the same way. On the fifth day the boy bathed in the sea, and on returning to the house was smeared with the red *intei* (tumeric) powder, and a feast was held. Only in the case of the son of a chief was there singing and dancing at the feast. Connected with it were no mystic rites, no badge, new name, marks, or hair-cutting, or freemasonry, or privileges. A betrothed girl, on reaching maturity, was taken with ceremony and feasting to the house of her betrothed husband, with singing and dancing.

Marriage.

In the case of children, the parents of the boy propose to the parents of the girl, and if the proposal is accepted a feast is held and the children are betrothed. The betrothed girl remains with her parents and in their house until she reaches maturity, when, as just said, she is publicly and with great ceremony conveyed to the house of her husband, the feasting lasting five days. Marriage is by purchase. Persons belonging to the same tribe (*Nakainanga*) are not allowed to marry; thus males and females of the *Nakainanga naui* (yam tribe) may not marry, and so of all the tribes. Children take their tribal classification, not from the father, but from the mother, that is, they belong to the tribe of the mother. In war they do not necessarily join the mother's kin, and those of the same *nakainanga* may sometimes be opposed in battle. As to the law of inheritance of land or property, the relatives seem to inherit, and a widow is regarded as a part of the property of the deceased inherited by them. A son-in-law and his mother-in-law avoid each other; the mother-in-law covers her face so as not to be seen by him, and if passing where he is keeps as far away as possible, and crouches low so as not to be seen. A son-in-law and his father-in-law also will not touch each other—though the restriction is not so great in this as in the former case, as they may be near and looking at each other. But if they inadvertently touch each other they have to go through a ceremony in which a pig is killed, to cleanse themselves from the stain. Two reasons for this are given—the one being that if they touch each other the son-in-law will be poor, or become poverty-stricken; the other (and proper one) being that if they do they will be *nimam*, and their eyes will be darkened (they will be weak) in battle. The wife has to weave or plait mats, cook, and also make her own plantation, and keep it in order. Her treatment greatly depends on the disposition of her husband.

The Tribe.

If by a "tribe" is meant a *Nakainanga*, what constitutes it is descent from the same mother in the female line, and the *Nakainanga*, as such, has no chief. Of the people of a village there may be several chiefs. The office of a chief is handed down by the chief to a successor whom he appoints and who is publicly, with pig-killing and feasting, designated or appointed. But the chief does not appoint his own son, but

in preference to all others his sister's son, who by the law of the *nakaivaga* is considered nearer and dearer to him than his own son, and to be his proper heir. The reason is that his sister's son is of the same *nukainaga* as he, being of his mother's (his sister's*), whereas his son is of a different *nakainaga*, being of the same as his mother (his wife's). The power and authority of a chief can only be exercised within certain defined limits. In matters involving religious considerations the chief's power is limited by the priest, or *natamole tabu*, and in purely civil or political matters by the council of the old men and influential men of the community.

There was of course no written constitution or laws, but the customs handed down from antiquity were rigidly adhered to. To the question, "Is there a tribal council?" it must be replied that this word *tribal* has to be defined before the question can be answered. The tribe, *i.e.*, the *nakainaga*, is a family, all the members of which are considered as closely related to each other, and bound to treat each other well. All the members of a *nakainaga* in a particular place were to a large extent responsible for the conduct of any one member; for instance, they had to pay a fine incurred by him, if he could not pay it himself. Hence, as above said, a boy was carefully instructed by, not his father (who belonged necessarily to another *nakainaga*), but by his *aloana* (his maternal uncle) his mother's full brother, who was necessarily of the same tribe and who regarded him as his heir. Now the older members of the *nakainaga* were the fathers, so to speak, of the family *nakainaga*, and exercised a kind of parental authority over it. But if by "tribe" be meant the whole people of a village, no definite statement can be framed applying to all such communities. But generally the chief had to consult the leading men in the village, that is virtually all the people, before taking action, as otherwise they might not support him in it. As to infractions of tribal law, the mind of the tribe having been ascertained, its chief declared the sentence, which might be a fine or death.

Social and Domestic.

The huts were built by erecting a wooden framework and covering it with thatch. The thatch might be reeds or long (sword) grass and cocoa-nut leaves plaited, or the former alone. The usual shape of the hut was that of a ship turned

* That is, his sister by the mother's sister.

upside down, with only one opening in the middle of one side for an entrance. Food was usually abundant, though there was a time of scarcity (comparative) every year, from December to March, while the yam crop was ripening. The principal articles of food are yams, bananas, cocoanuts, sugar-cane, and breadfruit, also fowls and pigs. The yam is cultivated with great care and labour, and in a manner that could in no way be improved upon by the highest European skill and industry. Every year a new piece of jungle is cleared, burned, fenced in, and cultivated. Both husband and wife work at this, each having a separate plantation in addition to helping each other. The fencing is usually done by the men. Only one principal meal is cooked each day, in the evening, and eaten about 7—8 p.m., the men eating by themselves. Before eating this meal one of the men offered a portion of the food to the spirits *(natemate)*, till which had been done, no one began to eat. When hungry, one would say, "give the offering to our *natemate* and let us eat." The food is cooked in an "oven," that is a hole in the ground lined with heated stones; the food, wrapped in leaves, is laid on these, covered with heated stones, and then the whole covered with earth, &c., until thoroughly baked. The ornaments worn on the head were a bunch of feathers, and sometimes pigs' tusks attached to the hair round the base of the skull. Tortoise-shell rings were attached to the ears. A white smooth shell was inserted in the septum of the nose. Armlets were of tortoise-shell, pigs' tusks, or the *panipin*, an elaborately woven armlet. Shells were also hung round the neck. Cords dyed with some dye obtained from the sea were wound round the waist or the legs. The clothing of the men consisted of a hand-woven mat girdle round the loins, to which was attached a bark cloth waist-cloth. This bark cloth was made in the same way as the similar cloth in other parts of the Pacific. The dress of the women was not so decent, consisting of a belt of strings to which was attached a woven mat of small dimensions, terminating in a bulky fringe. The men often had a fillet round the head. The hand-weaving of mats and the making of bark cloth employed the women, who had also all the household cooking and a share of plantation work to do. The men had to do a share of plantation work, the cooking at the public *(farea)* house of the village, to make canoes, to cut down the logs for *napeas*, haul them to the village *malel*, hollow them out, and set them up, and to fight in war. The natives are well nourished.

Wizards.

The general name for this class of persons is *natemate tabu.* The man is made a *n. tabu* by a communication from the *natemate.* The *natemate* are of two kinds, the spirits of deceased men, and the spirits whose origin is unknown. The latter give the necessary character to the *n. tabu.* One of them, for instance, appears to him in the form of a snake or lizard, or in a dream. In the former case he makes a small sacred enclosure called *butut*, and puts the snake or lizard into it, when it becomes a stone. When he wishes to cure a sick person, or to cause some one to die, he takes an offering to this stone (in which the *natemate* is supposed to dwell), in the *butut.* It is the *natemate* that makes efficacious his *koro* or incantation, whether this latter be for the discovery of theft, the recovery of the sick, or the death of some one. A peculiar class seems to claim the power of making rain. But the above is generally true of all classes of *n. tabu* whatever their special differences, though it leaves untouched all details. By the above means a *n. tabu* finds out why, for instance, the *natemate* are afflicting someone, perhaps the spirits of his deceased relatives. He directs the sick to appease these angry spirits by a sacrifice of a pig or a fowl, and to perform the duty his neglect of which has made them angry. The *n. tabu* is rewarded or paid for his services. I should say that the angry spirits are supposed to *possess* the man afflicted, and that the *n. tabu* exorcises them, on the above sacrifice having been made, and after his *koro.* He bids them *marua*, that is, cease from the man for the reasons he has recited. This is called *lualua*, that is, the expelling or putting out the *natemate.*

Deaths.

Natural death is supposed to be caused by the *natemate.* The *n. tabu* who are able to visit the spiritual world, or rather the under world inhabited by the shades, say in the case of a man whom they have tried to cure in vain, and who is about to die, that they in the exercise of their *natabuen* visited the world of shades, and attempted to bring away the shade of the sick man from there; and that the assembled shades drew the shade of the sick man into the cave where they dwell and shut the door, telling the *n. tabu* to begone, as the man was theirs (*i.e.* that he could not be saved from death). The underlying idea undoubtedly is that the man is doomed to death by fate or by the *natemate* because of some fault.

When life is extinct there is a long continued wailing. The body is washed, anointed with oil, and carefully dressed. *Nesei* (bright scented) leaves are fixed in his girdle, and a crown of feathers fixed on the top of his head. The girdle is called "the girdle of the *nakainaga*." Friends in the village are then at liberty to come and put presents of cloth on the body ; these are presents from them to their deceased relatives in the world of shades that he is about to visit. When he reaches Hades each will know the present that is his and strip it off him, leaving him at last with only his own *nafona nakainaga*. Then all who wish approach the corpse and attach a *neluko* (rope for tying a pig) to the fingers of the dead. Each *neluko* represents a pig about to be killed, the spirits of which offerings he will take with him to Hades. In the middle of the wailing some women (near relatives) cover themselves with ashes, or take shells and scrape the skin off their cheeks and temples. They wrap themselves in filthy old mats for clothes. The chief mourners blacken their faces.

In case of a chief, his *atafi* (successor) leads a few men to dig the grave; while this is being done, a dead and fearful silence is maintained in the village. To the sound of the big drums (*napeas*), the body is carried out and lowered into the grave; this done, a pig is killed. After the grave is filled up the *kali* (digging-stick) is carried six (or some *even* number of times, according to some) times round the mound, and then carried to the sea, all keeping out of the way of its carrier, into which it is thrown. A stone is set up at the head of the grave. Such a grave is called *zakkes* in Efate. It is sacred. On Mai on the fifth day the *karan* (cutting instrument) used in digging the grave is taken to the sea, all the community assembling there. After it is thrown in the sea, all bathe. Then the sea shore for a mile or two is pronounced "tabu," and no fishing or bathing allowed in it. The chief mourners up to this time have remained in the house. Feasts are held every fifth day up to the hundredth day, when a great feast is held, and after that the *intamate* is to be prepared for perhaps two or three years, during which a *napea* has to be cut down (a big log), hauled to the village *malel*, hollowed out, the face of the dead carved upon it, set up in the *malel*, and a series of festivals (feasting, dancing, singing) held. On Efate the chief mourners remained in the house thirty days; on the conclusion of the *intamate* the *napog*, that is, insignia of the chief, is buried in his grave. On Mai they buried

some yams, &c. in a bucket with the body, and also one or two weapons, as a club, bow, and tomakawk. On Efate it was usual to see a little basket hung over the grave with food in it. Human beings used to be killed at the death of a chief. One was thus killed on Efate about five years ago. On Mai, about six or seven years ago, on the death of a chief, three of his wives (one of them the sister of one whom I have trained to be a teacher, and who is a splendid fellow) were buried alive in the same grave with him. On the death of another chief, three men were killed and their bodies sent round to neighbouring villages to be eaten. On Efate, sometimes a dog was killed instead of a human being, immediately on life becoming extinct.

The Spirit World.

The spirit world is below, and is called *Abokas.* It is down under the surface of the earth and beneath the sea. In Efate the entrance to it is at the western side of the island at a place called Tukituki. At a point on the coast there is a remarkable tree. The departed spirit climbs this tree, which is close to the sandy beach, on which there is always thundering a heavy swell. He calls a spirit, whose name is Tafatokei. Tafatokei ascends from the under-world, and comes out of the sea. At the same time the sea sends a big wave up to the roots of the tree; this wave receding carries the ghost with it. If he has been buried through the day he has to wait on a certain rock till sunset, when he is admitted to Hades among the other *natemate.* Hence, to keep the departed spirit from so having to wait, the Efatese do not bury till evening. At the entrance or gate of Hades a tremendous being named Sara, or Sara-tau, has to be passed; with him are four officers, Vaus, Maaki, Maseirut, and Maseasi. Vaus asks as to the new comer, "Who?" If Maaki answers "I don't know," Maseirut clasps him round and holds him, while Sara cleaves his forehead, and twist his head backside foremost, and Maseasi gouges out his tongue from the root. If Maaki says "He is one of ours," Sara lets him pass untouched. Even here the *Nakainaga* comes into play; Sara is said to be of the *Nakainaga namkat* (a kind of yam), and to allow any of that *Nakainaga* to pass unharmed. People of other *nakainagas* put a fillet of *namkat* leaves round their heads to deceive him; but he discerns their hypocrisy from the withered aspect of the leaves. Some of the *nakainagas* pass him unharmed by

stripping off from their bodies tatoo marks and presenting them to him; these marks were sometimes cut into their flesh in mourning for the dead, and sometimes in the worship of a being called Wote, as it seems—certainly in the former case. Another curious practice was, at the death of a chief, to kill a dog, which dog was to accompany him and "*Koba Sara*," that is, to drive away Sara, so that his master might pass unharmed into Hades.

Though the spirit has been admitted into Hades, it is still able to revisit its former abode in this world, and to punish men for faults. Thus, a man is sometimes doomed by the *natemate* for desecrating the grave of a chief by merely walking over it; or for spitting near some *fatu tabu*, "sacred stone;" or some man and woman are both doomed for committing adultery in some sacred place, *alia tabu*, to which they have gone, so that men should not see them (such places being much feared and avoided). Again, if a man is wicked and oppressing others, the *natamole tabu* goes to the grave, "*namatigo tabu*," of the chief, and presents an offering and beseeches the *natemate* to destroy him for his wickedness; such a man's fate is evil,—a shark eats him, or his canoe drifts or founders, and he is drowned, or he falls from a tree and is killed. A man in fear or distress calls upon the *natemate*; thus, if one is out in his canoe and a storm arises, he prays to them, saying, "*Mama* (as the case may be, or *lolo* = maternal uncle) father, cause this storm to cease, and bring me safe to shore, and I will kill a pig (in sacrifice, or to appease your wrath) to you," the idea being that the threatening ruin is coming upon him because he has offended by his deeds. So, if he is sick, or in pain, he calls upon the *natemate*, and is willing to make any sacrifice to appease their wrath (*turi namaieto ni natemate* = appease the wrath of the natemate).

Abokas, or Hades, is a dark place, and contrasted with this (the upper) world which is called *Emeromina*, that is, "place of light." It is gloomy and sad. There is a great stagnant pool in it, or marshy place, called *Ra-les*, gloomy place, or lake. It is considered, as above indicated, that death is a punishment. Accordingly, when a man is behaving wickedly, they say, "they (*i.e.* the *natemate*) have already planted for him the *nales* (a plant with thick dark leaf) on *Ra-les*," or, "his soul has rlready gone to *Wora Tuk*" (= place of the pit). Everything is shadowy and unreal in that fearful place. When the *natemate* makes an oven

and cooks food, on opening the oven nothing but dirt is found in it. A story is told of a man who died and went there, his wife also died, and when he saw her in Hades, he attempted to embrace her, but he became mere dust on her bosom, and failed in the attempt. One is reminded of Virgil's words, though spoken not of attempted embraces, but of an attempted war cry in Hades,

"Inceptus clamor frustratur hiantes."

It is said that Hades consists of several stages, one below the other, and that a man dies in all six times, each time descending to a low stage. The first time he dies in this world and descends to *Abokas*. On entering *Abokas* he is admitted among those who have died before him, and recognises those whom he had formerly known in the world and is recognised by them. His mother, however, treats him with every evidence of contempt and hatred; on the contrary his paternal aunt treats him with great kindness. A man who has been buried with honour, many pigs killed, much food offered, &c., is comparatively well off in *Abokas*. As the manner of his burial depends on his character among his fellows and the amount of property he had acquired by his industry, it is a great object of ambition with the natives to have a good memory behind them and a large amount of property that they may be honourably buried and correspondingly happy in Hades. A worthless fellow is liable to be buried with the burial of an ass, and to correspondingly suffer in Hades. Wild with hunger there he can only get a hard kind of shellfish to eat; in eating it his jaws are torn and bleeding, and he has time to bethink himself of the evil fate his worthlessness has brought upon him. After an indefinite time one dies in *Abokas*, and descends to the next lower Hades called Magalululu. Again, after an indefinite time he dies there and descends to Magatiro. Then in like manner to Magaseasea. Then to Magatika. In *Abokas* he is a *natemate*. In the succeeding places he, it seems, turns into lower forms, as those of rats or snakes; but this is doubtful. Finally he disappears from Magatika like the down of a certain plant carried away though the air, or a puff of white vapour lost in the atmosphere, or the husk of a certain fruit floating away out to sea.

Mythology.

The idea of a creator, or of creation, in the strict sense of their words, does not appear to have existed among the

people. But it is said that two beings—men—Mauitikitiki, and his *sulina* (offspring or grandson) Tamakaia were the first men, Mauitikitiki having a wife. A contest for superiority arose between Mauitikitiki and Tamakaia, and Tamakaia proved his superiority by, among other things, hauling or fishing up the various islands constituting the world known to the Efatese ancients, from the sea. At first the sky was close to the surface of the earth. According to native story, a woman was raking out the stones of her oven with a pole which stuck in the sky; she then smote the sky with the pole, and angrily bade it ascend out of the way. It ascended and ascended far beyond her wish, and kept on ascending notwithstanding her entreaties to the contrary. At the beginning a chief on Meli had two children which were always crying and never sleeping, because the sun never set, and there was no darkness or night, but only perpetual day, and therefore no sleep and no rest from labour or vexation in the sweet oblivion of sleep. He set out in search of night and darkness, and, after going round the island, was directed to the most eastern point to a place called Baulelo. Here, having his bamboo ready, he caught the darkness of night and sleep as it arose from the sea, and enclosed it in his bamboo. Returning home he dispensed at every village on the way these blessings which thus became the common inheritance of all. According to one story, all things as yams, pigs, &c., came down from Heaven, which is said (like Hades below) to consist of several stages, one above another (six heavens). The story runs thus:—The people of Heaven used to come down, take off and lay aside their wings, or "sails," and fish at low water by night. In the morning, putting on their wings, they chanted a song and reascended. A man watched them and hid the wings of one, a woman, who therefore could not reascend, and whom he took to wife. She bore two sons who had no name; she said, let them be called by whatever name by which they address each other. Thus, the one was called Karisibum, and the other Makatafaki. She afterwards found her wings and returned to the sky. Her two sons, after they had grown up, were able to follow her. They brought, or let down in a large basket, the different kinds of yams, &c., with which the world is filled. The basket, let down by a rope and swinging about, at last became fast between two mountains, from whence the things in it were taken to all the surrounding places. This is evidently not a creation story. Among the first men at the dawn of the

race, it was being disputed whether men should renew their youth perpetually *(mulu)*, or die *(mate)*, having begotten children who should take their places. A bird called Pilake (the name means "mortal terror") burst upon them, exclaiming, "What are you talking about? I have already buried my father and mother: beget those who shall grow up and multiply instead of them." Thus was established the present order in which men die and one generation succeeds another. Another bird called Man-tangisi-nerei (*i.e.* "the bird that bewails men"), on hearing this doom of death pronounced by Pilake, bewailed men with tears: hence the red marks under its eyes to this day. The general name Natemate denotes both the spirits of dead men which have lower divine powers, and afflict men by possessing them, for instance, and those spirits (or *deities*) whose origin is unknown. These latter give the natabuen to the natamole tabu (sacred men). The natemate natamole (spirits of dead men) have, however, powers of deliverance also, as may be seen from the above.

Philology.

Pronouns.

	Separate.	Verbal.
I	Kinan	A.
Thou	Nago	Ku.
He, she, it	Nai	I.
We (exclusive)	Kinami	Au.
We (inclusive)	Nigita	Tu.
Ye	Kumu	Ku.
They	Nara	Ru.
We two (exclusive)		Ara.
We two (inclusive)		Ta.
Ye two		Ko ro.
They two		Ra.

Numerals.

	Cardinals.	Ordinals.
1	Sikei	Be.
2	Rua	Kerua.
3	Tolu	Ketolu.
4	Vate	Kefate.
5	Lima	Kelima.
6	Latisa (lima tesa)	Kelatesa.
7	Larua (lima rua)	Kelarua.
8	Latolu (lima tolu)	Kelatolu.
9	Lifiti (lima bate)	Kelifiti.
10	Rualima (rua lima)	Keralima.

Distribution.

Sikeskei .... One by one.
Ruarua, &c.

Multiplication.

Bakasikei .... One time, once.
Bakarua, &c.

How many? .... Bīsa, or bīa?
Who? .... Sei? (dialect) Fei?

What?...................... Sava? Sā? (dialect) nafete.

This.................. Ua, sĕ, kĕ na, naga, nis, kis, &c.
That.................. Uān, netu, &c.

Paradigm of Verb "go," ban.

Present and Past Indicative.

Singular.

1 A ban .... I go.
2 Ku ban .... Thou goest.
3 I ban .... He goes.

Plural.

1 { Au ban (exclusive) ... We go.
  { Tu ban (inclusive)...... We go.
2 Ku ban.................. You go.
3 Ru ban .... They go.

Past.

1 Aka ban .... I went.
(As before, suffixing *ka* to the verbal pronoun).

Pluperfect.

1 Akai ban.................. I had gone.
(As before, suffixing *kai* to the verbal pronoun).

Future.

1 Aga no ban............... I shall go.
2 Kuga no ban .... Thou shalt go.
(And so on, putting *ga no* immediately after verbal pronoun).

Present Progressive.

A bo ban .... I am going.
(And so on, putting *bo* after verbal pronoun).

Subjunctive, Permissive, Conditional.

Present and Future.

1 Aga fan .... I may (&c.) go.
(And so on, putting *ga* after verbal pronoun).

Perfect.

1 Agai ban.................. I may have gone.
(And so on, putting *gai* after verbal pronoun).

Imperative.

Singular.

2 Ba fan .... Go thou.

Plural.

2 Ko ban .... Go ye.

The 3rd person is expressed by the subjunctive.

Infinitive.

The verb in its simplest form is often put after another in the infinitive, which, however, is usually expressed by the subjunctive ; as, I told him to go—*iga fan* (that he should go). The infinitive is expressed also by the verbal noun now to be considered.

The Verbal Noun.

Nafanoen, or nafanoan(a) (the original form), the going.

This is composed of the article na, and the formation ending *en*, or *an*, and may be formed from every verb in the language. The *o* in nafanoen belongs to the word ban, which pronounced fully is bano, to go. Nafanoen anena, his going. When the verbal noun is used without the article it is the verbal adjective with passive sense, as *tea fanoen*, what is for going, *nabua fanoen*, a road to be gone on.

The simple form of the verb placed after a substantive, or substantive pronoun, without the verbal pronoun, is an adjective, as *tea ban*, that or those going—the going ones, *natomole bano*, the men going, or going men.

The verb "to kill" with a pronominal object :

As this and all other verbs are conjugated exactly in the same way as the above "ban," to go, it is only necessary here to show how the pronominal object is attached to the verb. Thus, if we take for the verb "to kill," *bunu*, literally "to make an end of," and which signifies to extinguish, to finish, to kill, &c. :—

Bunuau	Kill me.
Bunuako	Kill thee.
Bunuea	Kill him, her, or it.
Bunuagami.........	Kill us (exclusive).
Bunuagita	Kill us (inclusive)
Bunuamu...........	Kill you.
Bunuera	Kill them.
Bunu natamole ...	Kill men.

LIST OF WORDS.

(The article prefixed is in italics).

Man	*na*tamole.
Woman	*na*guruni.
Head	*na*bau na.
Hair of	*na*lulu na.
Eye	*na*meta na.
Nose	*na*gusu na.
Tongue	*na*mena na.
Ear	*na*taliga na.
Hand	*na*ru na.
Thumb	kin liba.
Foot..................	*na*tuo na.
Bone	*na*fatu na.
Blood	*ni*tra na.
Fire..................	*na*kabu.
Water...............	*n*oai.
Sun	ēlo.
Moon	atelagi.
Father...............	afa.
Daughter	nani*na* *na*guruni.
Mother	pile na.
Son	*n*ani na *n*anoi.
Brother	tai na.
Sister	gore na.
Cousin...............	tai na.
Uncle	aloa na.
Aunt	mīm.
Give	tu.
Take.................	tabe.
Make	bati.
Bear	sela.
Burn	tapara ki.
See	libi.
Hear	rogo.

12.—THE ORIGIN OF THE SENSE OF DUTY.

By A. SUTHERLAND, M.A.

Section H.

SANITARY SCIENCE AND HYGIENE.

PRESIDENT OF THE SECTION:

PROFESSOR WARREN, M.I.C.E.

1.—NOTES ON THE ETIOLOGY OF TYPHOID.

By E. O. GIBLIN, M.D.

In writing a few notes on Typhoid Fever, more for the sake of eliciting information from others than with any idea that I can add much to the knowledge of those present, my recollection goes back to the year 1862, when the news reached us that typhoid had claimed Prince Albert as a victim; ten years later, when in London, I well remember the tension of the English people during the illness of the Prince of Wales from the same disease, and vividly recall the lecture which Sir William Gull gave the students of Guy's Hospital after he had received the well-deserved reward of a baronetcy as a recognition of his merit, when with one stroke with chalk drawing an arc on the blackboard to represent twenty-one days' temperature, he tersely remarked, "That's Typhoid Fever"; and now we have daily bulletins cabled all over the world telling us of the gradual recovery from typhoid of another member of that apparently susceptible family. Unlike smallpox, which has found its master, and is no longer the dreaded scourge it was before the days of Jenner and vaccination, typhoid to-day is found in the house of monarch and subject, of rich and poor alike. In England, the birth-place of sanitary science, no preventive has as yet been discovered, and in Australia and Tasmania it is to-day a dreaded scourge, endemic to the soil, claiming yearly as victims hundreds of our population, principally the bread-winners of the family, the young, active, hard-working, and hard-thinking members of society, and, where the issue is not a fatal one, causing incalculable anxiety and expense. During the past five years, especially in the year 1887, the disease has from time to time appeared in an epidemic and virulent form throughout all the Australian

colonies. During 1891 in Hobart, under sanitary conditions apparently precisely identical with those in 1890, there were 54 deaths registered in the Hobart district; in 1890 only 14. To-day the fever wards of our hospital are almost empty; last August and September they were crowded and overflowing. Practically there is no fever in the town beyond the four cases in hospital, two of which are convalescent; next March or April there may be 40 or 50 cases, the hospital being taxed to its utmost capacity.

What are the conditions which favour or disfavour these typhoid epidemics?—Where, and how, is the typhoid poison lying dormant ready to burst out upon the community?—What are the vehicles of communication by which it reaches the human subject?—How best can it be neutralised, rendered inactive, or innocuous? In short, what are the teachings of sanitary science in regard to such a town as Hobart, and in reference to this disease of typhoid fever? This is an all-important question from a practical point of view, and although as a busy medical man, and not a bacteriologist, I do not pretend to be able, and indeed shall not attempt to answer all these questions—still I should like to elicit your opinions and your sympathy. As Officer of Health of this city, I should like to take advantage of the visit of this Association to our town and obtain the advice of this section as to the best preventive means to adopt to ward off or minimise our annually recurring typhoid; and I feel I do not appeal in vain, for Hobart is no exception—the disease in Australasia is ubiquitous, and its cause and prevention must have been a subject of thought to every one present. Let me very briefly refer to a few of the recognised channels by which the typhoid poison has been known to travel, and see how far they are to blame for the annually recurring visitations. Incidentally I shall allude to other points raised in the questions I have propounded, but shall not minutely discuss these, each being sufficient for a single paper.

Water.

It is a well recognised fact that water contaminated with sewage to which the typhoid poison has had access, is a frequent cause of the spread of this disease. All impure water will not produce typhoid, or typhoid would be more prevalent than it is; it is only water which is actully impregnated with the typhoid poison which is capable of producing typhoid. Hirsch, in an article on Typhoid Fever in his

Geographical and Historical Pathology, writes as follows:—"A more frequent and more extensive source of infection is water for culinary purposes which has been contaminated by the typhoid poison. I take it that few points in the etiology of typhoid are so certainly proved *as the conveyance of the morbid poison by drinking water* or by food contaminated with drinking water." Investigations by sanitary authorities into outbreaks of typhoid have established this fact beyond dispute, for it has been clearly shown that there had been previous typhoid contaminations of the water supply, and that the outbreak ceased immediately the use of the water was discontinued. Hirsch gives the details of such investigations on outbreaks at Stuttgart, Millbank Prison—Berne, Caterham, and Red Hill and other places; while the exhaustive reports on the outbreaks of typhoid at Babranald and other places by Dr. Ashburton Thompson clearly demonstrated that infected drinking water was the cause of the spread of the disease. In Hobart I do not think that our water supply is to blame for our annual typhoid; our water collected, principally from behind Mount Wellington, is clear, bright, spring water, containing very little organic matter, and its collection is almost outside the possibility of typhoid infection; but there is a bare possibility that in its distribution it may become contaminated with sewage, which sewage is laden with typhoid poison. Dr. Gresswell, of Victoria, has particularly emphasised the possibility of such infection owing to the use of Bateman's fireplug boxes, the india-rubber ball-plug dropping when the pressure is removed owing to an intermittent supply, or during repairs, thus allowing sewage, perhaps contaminated with dejecta from a typhoid patient, flowing down the adjacent sewer to be sucked into the pipes and distributed to the houses for drinking or culinary purposes. While admitting that the fire-plug boxes often contain muddy water which may be drawn into the supply pipes, and while insisting on the thorough cleansing of these boxes, and the maintenance, as far as possible, of a good pressure, I do not think that many cases can be attributable to this cause, as we should have many more cases in a household or in a district than now occur.

Milk.

Another vehicle for the conveyance of the typhoid poison is milk. Many careful investigations into typhoid epidemics have demonstrated conclusively that the milk from one

particular dairy, an inmate of which was suffering from typhoid, has infected many of the consumers of that milk; or that the milk has become contaminated not by a typhoid patient in the house, but by the addition of water from a well, or washing the cans in the water of a well contaminated with typhoid dejecta. Both in England and in the colonies many epidemics have been traced to a polluted milk supply, but I am not aware that in Hobart, for many years past, milk is responsible for spreading typhoid. In investigating cases of typhoid I have never come across two cases supplied with milk from one dairy simultaneously attacked. It is perfectly true that our dairies are not all that they should be; the cows are often poorly fed, the cowsheds badly paved and badly drained, the milk exposed to effluvia from manure heaps and offensive drains; still, as I said, I do not think that our epidemics are due to milk, although the day is not far distant when those who undertake to provide food and milk supplies for the public must be prepared to guarantee the greatest cleanliness throughout their business. As Dr. Gresswell, of Melbourne, aptly says, " The evidence that is accumlating as to the relation of milk to tuberculosis, to typhoid fever, to scarlet fever, to diphtheria, and to other diseases in man, demands the exercise of the greatest care concerning the health condition of cows, and the mode in which milk is dealt with while in transit from the cow to man."

Oysters.

In addition to polluted water and milk as possible and frequent causes of typhoid infection, my attention was last winter drawn to another article of frequent consumption which is also generally eaten uncooked—I mean oysters. Case after case of typhoid occurred amongst young men who upon enquiry stated they were in the habit of eating oysters—indeed it was owing to the greater prevalence of typhoid among men that my suspicion was aroused. Further enquiry as to the mode of storage and distribution of the oysters showed that after arriving in the port they were stored on trays in the salt water near the new dock, the oysters which had perished in transit being as far as possible picked out from time to time. In close proximity to these storage trays was daily pumped the water which had soaked from the subsoil into the dock then in process of excavation. Into the harbour are also discharged many sewers carrying excreta, perhaps the dejecta of some typhoid patient, which in the

often quiet water of the cove, might be deposited on or in the feeding oyster, to be distributed and eaten. Here at least seemed such a complete chain of possible cause and effect that steps were at once taken to have the oysters removed and stored in the river away from the chances of infection from the town drains.

Other Channels.

But it is not only by means of food and water that the typhoid poison finds an entrance to the human organism. In investigating the surroundings of each case it frequently happens that the patient can distinctly trace the first onset of the disease to having inhaled an unpleasant odour from some street, gully, or drain, or pan. Here it is the air, not the food or water, which is the vehicle of the poison. In many towns with ill-ventilated sewers typhoid has been clearly traced to the sewer gas getting into the houses, or to emanations of foul air from a sewage-laden soil. And in endeavouring to explain the cause of typhoid in Hobart year after year, I am reminded of the past sanitary history of Hobart; that for half a century the surface of the ground in Hobart has been, so to speak, pitted with badly constructed cesspits; that until the establishment of our present system—that is, until four or five years ago—the soil and subsoil of the town from one end to the other was being daily polluted by leaking cesspits; that these cesspits, even on the establishment of the present system, were never adequately emptied and purified, and frequently, for years previously, were never emptied at all, rain-water and drain-water reaching them in many places. What was removed from one place in the town was often buried in another; land which required raising was filled in with the contents of ashpits, with decomposing garbage and refuse; so that, in my opinion, the subsoil of Hobart is fouled with half a century's drain and cesspit and other pollutions, which drain pollution is still going on in many places, though I am thankful to say that cesspits have for some years been discontinued. Still the old pollution remains; great as is the purifying influence of the soil the task has been too great; and as this soil pollution travels underground, borne along by rain and drain waters, its emanations permeate the porous upper soil and are drawn into the houses to poison with typhoid those who are susceptible to the disease. Hirsch, speaking of the part played by the soil in the development or diffusion of the typhoid poison, says:—"In all probability the soil serves as a breeding-place for the

virus which reaches it, either from cesspits, or ashpits, or directly, and comes to maturity in it under the influence of the decomposition processes undergone by the fæcal matters which had percolated along with the virus, or had accumulated previously. It cannot be denied, *a priori*, that fluctuations of the subsoil water, or in other words the entrance of air into ground previously saturated and then left dry, which follows therefrom, is particularly calculated to further putrefactive processes; and in this way may be explained the influence of fluctuations in the subsoil water on the number of cases, or, in other words, the fact that typhoid reaches its highest point after a great fall of the subsoil water, and its lowest after a considerable rise. The virus having become potent, can now be carried from the soil into the atmosphere, and it will so get introduced into the human organism with the breath." Notwithstanding the obscurity which still hangs over all these questions, no one can deny the importance of the soil as the breeding-place of the typhoid poison. No doubt typhoid develops under circumstances where any influence of the soil is not only highly improbable but even excluded as an etiological factor, as in epidemics in rooms; but those cases are by no means in contradiction of the theory—they serve rather to corroborate it, inasmuch as the same conditions that cause or assist the typhoid poison to ripen or acquire potency in the soil may be met with also outside the soil.

Even at the expense of tediousness, I cannot refrain from making another quotation from Hirsch which seems specially adapted to our condition. Speaking of the pathogenetic influence associated with the inadequate removal of animal exuviae, with accumulations in cesspits, drains, and the like, or with the percolation of those matters into a porous soil to which air and moisture have access, he says:—"There are few points in the etiology of typhoid on which there is so much agreement in the opinions of observers as on the influence exerted by these nuisances on the development of epidemics or endemics of typhoid, or on the occurrence of isolated cases; one learns how, amidst seemingly good hygienic circumstances, the conditions for an outbreak of typhoid fever are furnished by badly laid, insufficiently emptied, choked, or ill-ventilated drains, by leaking or overfilled cesspools and the like; we see cases of typhoid singly or in groups beginning to occur, from the moment the noxious influences associated with these nuisances make themselves

felt, and precisely amongst those who occupy the rooms or buildings exposed to those influences in one way or another, and we find that the attacks cease to occur when the defects are repaired. But evidence on a large scale for the importance of this etiological factor in the production of typhoid is furnished by the lowering of the typhoid sick-rate and death-rate in towns, through attention to the cleansing of fæcal matters from the streets, the houses, and the soil, and through an efficiently carried-out system of drainage and sewerage."

Believing then, as I firmly do, that the pollution of the subsoil is the main, I will not say the only, factor in the etiology of typhoid in Hobart, I cannot help rejoicing at the near establishment of a system of underground drainage by the Metropolitan Drainage Board recently constituted by Act of Parliament. And I trust that before this Association next holds a meeting in Hobart the whole system will have been perfected and carried out. This will be a double boon; it will provide for our present needs by a water-carriage system, and it will atone for our past ignorance and misdeeds by opening up and draining and aerating our polluted soil. During the progress of the work fever of a typho-malarial type may be rife, but in the end benefit must accrue, and typhoid, instead of a perennial resident as it now appears to be, become a very occasional visitor.

In alluding to the etiology of typhoid, I must not omit to notice one factor to which special attention has already been drawn in Hobart. When typhoid assumed an epidemic and virulent type throughout the Australian colonies during the year 1887, our eminent Statist, Mr. R. M. Johnston, read a paper before the Royal Society of Tasmania, in which he attributed the epidemic variations of typhoid to the operations of three great causes—(1) Local hygiene, (2) Seasonal influence, (3) Cosmical influence. With the first of these causes, local hygiene, as modified somewhat by the second, seasonal influence, rainfall, &c., I have been principally concerned in these notes; and as to the third, cosmical influence, Mr. Johnston expressed his belief that such super-terrestrial phenomena as the spots on the sun are calculated to intensify typhoid epidemics and increase the death-rate.

2.—INFECTION IN DISEASE.

By C. E. BARNARD, M.D.

It is my intention in this short paper to give a bare outline of some of the more recent advances that have been made in the direction of the causes of infection.

Generally speaking, the word "infection" means the transmission of a disease from one individual to another, either by direct or indirect contact. The word "contagion" is sometimes used in a similar sense, but originally it meant the conveying of disease by contact only.

Formerly, before the present more exact methods of research were invented, little or nothing was known of the medium by which infection was supposed to be carried. The poisonous matter or contagium was, however, regarded as being endowed with vital energy, as it was known to be capable, when once introduced, of developing in the system, and of causing considerable constitutional disturbance.

The idea has long been prevalent that infectious diseases owed their existence and progress to the presence of some ferment setting up a process of fermentation in the system, and hence they have been grouped together under the term "zymotic diseases." The morbific material setting up the disease was supposed to act similarly to a ferment in the process of fermentation, and to be derived from an infected person.

When fermentation was found to be due to the action of microscopic cells which multiplied rapidly during the process, and likewise that microscopic organisms were found to be always more or less intimately associated with the zymotic diseases, the analogy was regarded as complete. Thorough search was then made for micro-organisms in the blood and tissues of persons suffering from infectious diseases, and, as only particular forms were found in each disease, the specific micro-organisms were looked upon as the ultimate cause of infection.

It was not until the year 1876, when Koch discovered the means of isolating and cultivating in nutrient media outside the body a bacillus, the B. *anthracis*, that the life history and morphology of other bacilli could be properly studied. This discovery laid the foundation of the modern science of Bacteriology.

The micro-organisms are the smallest living beings with which we are acquainted, and are composed of a living

substance called protoplasm, which is contained in an envelope containing cellulose. The protoplasmic interior cannot have the same chemical constitution in all bacilli, as these show varied reactions to staining and reagents.

These microscopic organisms or microbes may be roughly divided—so far as disease is concerned—into two main classes—the pathogenic, or disease producing, and the non-pathogenic, or comparatively harmless, which have no power of producing an infective disease. They vary in shape, being round or oval, when they are termed micro-cocci; rod-shaped, more or less elongated, when they are called bacteria, bacilli, or vibriones; spiral-shaped or spirilla; and besides these forms, there are wavy and filamentous varieties.

Being excessively light in weight, and microscopically small—varying from ·0005 mm. to ·05 mm. in length or diameter, they are easily carried about by the dust of the air, and in consequence are present everywhere—in the air, in the soil, and water.

The large majority of the microbes that are found in the air and soil are non-pathogenic; but the pathogenic ones are not absent, as their presence can be proved by the production of pathological effects when introduced into the animal system.

Bacteria, like plants, form well defined and constant species, and transmit their own particular likeness, although in some cases they may show some variation owing to external influences. Some observers believe that some non-pathogenic bacilli can become pathogenic by cultivation, but this is not generally regarded as correct. They each have their special functions to perform, whether disease-producing or not, but it is simply impossible for the harmless bacilli alone to produce the same dire effects that are only due to the pathogenic forms.

The micro-organisms of the infectious diseases have certain selective powers, as they are apparently attracted to particular organs, and find entrance each in its own particular way. The diphtheritic bacillus, for instance, does not invade the body generally, but attacks only the mucous membrane of the throat, where it remains without going farther.

In some diseases, such as hydrophobia, tetanus, and others, the virus or contagium of the disease finds entrance only by direct inoculation. In others, infection is conveyed through the air; and in others again, the infective matter is taken into the system in the food.

The microbes will be thus seen to have selective power or chemical affinities for particular parts of the body—the scarlatina contagium for the tonsil, diphtheria for mucous membrane of mouth, typhoid for bowel, glands, &c.

The diseases of animals which are transmissible to man do not appear to be communicable through the air, but only by direct inoculation or direct contact.

In whatever way the contagium is taken into the system, it has the power of multiplying therein, and of producing certain symptoms indicative of its onward progress.

The first symptom of the invasion of the pathogenic microbe is a rise of temperature of the body, which indicates that increased chemical action or metabolism is going on in the system in an unusual manner. Should the infection progress other symptoms show themselves, which prove the particular contagium which has given rise to the disease. And as each contagium only produces its own particular set of signs and symtoms—as from a seed only a particular plant is produced—so we have the specific infectious diseases defined accordingly.

The diseases that we have mostly to deal with, and which are officially regarded, according to the Public Health Act, to be "dangerous, infectious, or contagious," are smallpox, Asiatic cholera, plague, yellow fever, typhus fever, measles, scarlatina, typhoid fever, diphtheria, and whooping-cough.

As our knowledge increases, others no doubt will be added to this list; and already in some countries tuberculosis is regarded as belonging to the type of "highly infectious diseases."

Before coming to a decision that any particular bacillus was the cause of disease, Koch was guided by three rules which he laid down as his guides in his investigations, and it would be well if these rules were steadily kept in view with regard to all cases of infectious disease. The first principle is, that the bacillus must be found invariably in each case of the particular diseases; secondly, that it is not found in any other disease than the one to which it relates; thirdly, that the micro-organism can be isolated from the diseased body and cultivated outside in nutrient media, when a pure culture can be obtained from which the disease can be reproduced with certainty when inoculated into the animal system. The circle of proof would be thus complete, and the connection of the micro-organism with the particular disease clearly established. This series of proofs has been demon-

strated in numerous diseases, such as anthrax or splenic fever, tuberculosis, tetanus, diphtheria, and others.

The specific microbe of every infectious disease has not in all instances been yet isolated, but there can be no doubt by analogy that each infectious disease owes its infectivity to the presence of its own special micro-organism, and to none other, for its development.

As microbes have the power of forming chemical products by their growth and multiplication, as well as by their action upon the tissues with which they may be surrounded, it is probable that where no bacilli are found in the system, as in some diseased states—hydrophobia and tetanus for example—the morbid condition may be due to the action of these chemical products, which are easily absorbed and carried into the tissues of the body by blood vessels and lymphatics.

In diphtheria the microbes are only found on the mucous membrane at the seat of invasion, and not inside the body generally, and yet this is a very fatal disease, as if the system were poisoned directly by the absorption of the material produced by the microbes.

It appears, then, that in some cases of disease the chemical products of pathogenic bacilli are apparently the sole agents in the production of infection; in others, the specific microbes are wholly responsible for the disease; and in others, again, the diseased action may be due to the combined action of microbes and their products.

Some light may be thrown upon the action of these chemical products of microbes by considering the action of similarly constituted bodies. Albuminous substances taken into the system as food are split up by the action of true ferments or enzymes, such as pepsin and trypsin, into simpler substances, amongst which albumoses and peptones are the most important. These bodies in the ordinary process of digestion pass through the liver and help to nourish the system, but if separated before they enter the liver, and injected into the blood directly, they act as violent poisons. Their poisonous action is destroyed by boiling.

Products of pathogenic microbes have been regarded by chemists as albumoses, their action being destroyed by boiling. Roux and Yersin obtained a "soluble poison" from a cultivation of the bacillus of diphtheria, and found by inoculation that it produced all the symptoms of this disease.

These products derived from the decomposition of albuminous substances by the agency of microbes partake of the nature

of alkaloids, possessing alkaline properties, and having similar reactions to the alkalies, and resembling somewhat the alkaloids of the vegetable kingdom.

These alkaloidal bodies, called ptomaïnes and leucomaïnes, have been discovered in several of the infectious diseases, as typhoid fever, scarlet fever, anthrax, &c. The ptomaïnes are found in decomposing animal tissues, and leucomaïnes in the living body, both resulting from the decomposition of albuminous substances.

Besides these alkaloidal bodies there are uncrystallisable substances which are found associated with the others, and are more or less intensely poisonous.

All these products are more or less poisonous, and they poison the system in a similar manner to the microbes which produce them. Possibly the action of pathogenic micro-organisms may be due to the poisonous substances evolved by them in all cases, while the microbes themselves are the means of setting up fresh foci of infection.

As alkaloidal bodies (leucomaïnes) are found in urine in health as well as in disease, they may be regarded as excretory products which may become poisonous to the system if not sufficiently eliminated.

Besides these alkaloidal bodies, microbes secrete a special substance, which has a diastatic action upon albuminoids—acting upon them like a ferment and it is found that this ferment produces the same poisonous effect upon the system as the microbes which secrete it. The whole subject is surrounded with obscurity, but investigators have shown that pathogenic microbes not only can produce infection themselves, but that they also produce poisonous alkaloids as well as special ferments which bring about the same result.

3.—CREMATION: HOW FAR IS ITS ADOPTION DESIRABLE IN AUSTRALASIA?

By T. JAMES, M.R.C.S. Lond., *Moonta, South Australia.*

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Cremation as a step in sanitary reform is a practice as yet of very limited adoption in civilised communities. It is a method for the disposal of the dead, however, when practised under proper conditions and restrictions, which sanitarians deem faultless in respect to physical results. The most approved cremation, as you are aware, is a process

wherein the dead body is placed in a light shell and exposed in a furnace to a temperature of 1500° Fah., but without contact with the fuel. Cremation as practised in a modified Gorini furnace at Woking, England, is declared to be absolutely inoffensive. There is neither smoke nor smell. The body is rapidly decomposed into volatile matter and residual ash. The volatile products, before escaping by a chimney, are passed over a coke fire to ensure complete combustion, which entirely prevents the suspicion of a nuisance. The proximate result of the process is chiefly that carbonic dioxide, ammonia, and water are set free, and a pure white ash remains. The more or less oxidised mineral elements which constitute the ash form the only visible result. The ashes of cremated adults weigh from four and a half to seven pounds, and occupy a space from one-half to three-quarters of a gallon.

A cremation occupies, according to weight of body, from one to two hours. The ash of each cremated body, which is always innocuous and free from odour, may be placed at the disposal of the friends to be preserved, if desired, in a cinerary urn or casket, or formally buried, and thus restored to its rightful place—the soil.

Let us for a few minutes consider earth burial. What happens as a consequence of this mode of putting the dead out of our sight? The body, enclosed in a more or less enduring coffin, is placed in the ground and covered with a few feet of soil. For a term varying from about five to fifteen years, according to nature of the soil and weight of the body, a repulsive process of putrefaction goes on until, by the slow resolving action, the ultimate end comes with complete disappearance.

The body, after interment in the earth, according to Dr. Parkes, is resolved into carbonic acid, ammonia, sulphuretted and carburetted hydrogen, nitric and nitrous acids, and various complex and fœtid gases which get oxygenated into simpler compounds.

The emanations from a putrifying body in a concentrated form are deadly; diluted largely by the atmosphere, they are deleterious. The atmosphere in and around crowded burying grounds, especially should there be many shallow graves, gets tainted with the gaseous exhalations, which impair the health of those who live near and habitually inhale what, but for the proximity of a crowded grave-yard, would be wholesome air.

The soil of crowded cemeteries—and they all get crowded sooner or later—is liable to get saturated with decomposing organic matter. There is no security for the destruction of disease germs which may have infected and multiplied in the body while living, and which may even have been the cause of death. On the contrary, the evidence available points to the preservative action of the earth on disease spores. Pasteur has the strongest evidence in support of this contention in the disease known as the cattle anthrax. Animals which have died of this disease and have been buried become, after a time (a year or two), a source of infection to others that are healthy, but which might graze over the burying ground or in the immediate vicinity. This result is brought about most likely through the agency of earth-worms, which ingest the anthrax spores with their proper food and bring them to the surface, where they are readily formed in the casts. They can be discovered in the alimentary tract of the worm also. The spores getting on the herbage or in the water infect healthy cattle, which become similarly diseased.

In the year 1883 a Brazilian physician showed that yellow fever is caused by a micro-organism (*Cryptococcus zanthogenicus*) which, like the Bacillus anthracis, could be cultivated outside the body. It was found in the secretions and excretions of patients suffering with the disease.

He visited a cemetery where, about a year before, a person dead from yellow fever had been buried, and took away some soil a foot under the surface, and over the grave. The cryptococcus was plentifully found in it and then cultivated on gelatine and inoculated into guinea pigs: yellow fever was produced. Other guinea pigs confined in a small space near some of the same soil took the disease. This investigation of Dr. Friere is suggestive of serious doubt if earth burial is a proper proceeding in other infectious diseases.

It is not hard to imagine—and it may yet be proved—that in infectious diseases generally the burial of the dead leads to contamination of the soil, and possibly the air or water where the conditions are favourable.

The specific micro-organisms of diphtheria, typhoid fever, malarial fever appear, so far as investigations have gone, to survive in the damp soil.

Why is inhumation so generally in favour? It seems to be chiefly so as the natural outcome of long established custom, which has reconciled the living to the practice as the least repugnant to their feelings. Certain religious beliefs,

in the past strongly held, have supported the procedure. A writer in one of the medical papers has expressed very concisely the present governing sentiment favouring earth interment. "Burial," he says, "invests the grave with a certain inspiration as of the actual presence." It certainly seems to be a powerful factor with friends for deciding in favour of inhumation.

Having thus briefly dealt with the present mode of disposing of the dead, and indicated some of the consequences, let us now see what advantages are claimed for cremation. By this process the dead body is disposed of rapidly, and in a way which cannot be injurious to the living. It effectually destroys all disease germs which may exist in the body, and renders it harmless for any future infection. It obviates all the possible deleterious influences which earth burial may entail on the living during a prolonged term of putrefaction. Essentially it is a rapid progress of decomposition and purification during which the dead body, less a few pounds, is returned into the atmosphere in combinations available for the growth of vegetation.

Where poison has been criminally administered and the dead body cremated it prevents the chance of discovery. This is true without exception as regards vegetable poisons, such, for instance, as strychnine. Mineral poisons, as arsenic, antimony, &c., should they have been administered in any considerable quantity, would not be dissipated, and would be detectable in the ash.

The medico-legal objection, though at first sight formidable, is by no means insurmountable. Burial even does not give security for the detection of poisoning. Many of the most active poisons such as prussic acid, chloroform, chloral, &c., would leave no trace behind should exhumation and a chemical examination be instituted.

According to Sir H. Thompson, an average of only one judicial exhumation annually takes place in England. The medico-legal objection is readily overcome by a careful system of double certification; and where, after full investigation, any doubt exists as to the cause of death, the body should *not* be cremated.

After carefully looking at the evidence for and against burial and cremation respectively, I think we shall agree that the latter procedure is desirable, at any rate, where death follows infectious diseases.

In the course of time, as custom alters so will sentiment,

and with public sentiment favouring the new practice, all our dead, subject to strict precautions, should be cremated.

If we agree upon scientific grounds that the adoption of cremation would be advantageous to the living, steps might be taken in our larger centres of population to form local societies on the lines of the Cremation Society of England. Those who favoured incineration could then meet from time to time and take steps, as opportunity offered, to appropriately urge upon the public the advantages of the procedure over earth burial.

Private enterprise—should the various governments not be induced to construct cremation works—might step in and supply the desired accommodation. The initiative only could be undertaken by an association of persons, and as the practice grew in favour it would have to pass under State control.

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4.—ON THE MODES OF INFECTION IN TUBERCULOSIS.

By EUGEN HIRSCHFELD, M.D., *Hon. Bacteriologist to the Brisbane Hospital.*

Of all the diseases which are caused by microbic infection none seems to be of greater importance for the public health than tuberculosis in the various forms it attacks the human being. When we consider that one-seventh of all cases of death are due to tuberculosis, and in the most active age, between 15 and 35, every third case of death is caused by this disease, we easily understand that so deep an emotion was created lately by the announcement of the alleged cure of it from the same man who had made his name known all over the civilised world by his previous important discoveries in the same subject. About nine years ago Professor Koch first demonstrated that consumption of the lung was caused by the invasion of a minute vegetable being, the so-called tubercle bacillus, and that in whatever organ the bacillus penetrated exactly the same process takes place as in the lungs, which on account of its tendency to destruction and decay is popularly known by the name of consumption or phthisis (both words indicating that a consumption of lung tissue takes place). He proved beyond doubt that there is no tuberculosis without the presence of the tubercle bacillus and

wherever the tubercle bacillus has settled consumptive processes have begun to make their ravages. On account of the formation of small noduli or tubercles accompanying the destructive activity of the microbe in the healthy tissues, the disease was called tuberculosis, and we speak of tuberculosis or consumption of the lungs, throat, bowels, mesenteric glands, kidneys, &c., according to the seat of the disease caused by the bacterium.

It is the object of this paper to discuss the different ways by which consumption or tuberculosis might be propagated, since it is of great importance that the public should be educated to regard consumption as a disease of infectious nature, and by knowing all sources of infection to learn to avoid them.

There are three principal roads on which the tubercles bacillus attacks the human organism,—viz., by the respiratory apparatus by breathing; in the second place by the skin or direct subcutaneous inoculation; and thirdly, by the alimentary canal, by ingestion with the food.

1. By breathing. This is, without doubt, the most usual way by which phthisis is acquired. The expectoration of a patient suffering from tuberculosis contains a nearly innumerable quantity of the bacilli. The patient when he is coughing expectorates carelessly on the ground or on the floor, saturating by doing so the whole air of the room with the contagious matter, and impregnating the walls, carpets, clothes, &c. with the mischievous contagion. The spitting deposited in this way is allowed to dry up and turn into dust without losing any of its infectious qualities. It has been proved that dried sputum might retain its infectious properties for a period extending over six months. Especially the carpets and pocket handkerchiefs of phthisical patients are very dangerous indeed in this regard, and very fit to preserve the fatal poison for a long time, thus imparting the bacillus at any time to the respirated air. We therefore see that it is not absolutely necessary to come into direct contact with the coughing phthiscial patient for the conveyance of this minute vegetable being from one to another. That this is not exaggerated, artificial experiments, as well as every day's experience, have fully proved. Many authors, as Villemin, Tappeiner, Schweninger, and others contrived to produce consumption of the lungs in animals by adding to the breathed air dried-up phthisical sputum dust. A very interesting case is reported by Dr. Henry Toulmain and published in the issue of March

22nd, 1890, of the *British Medical Journal.* The patient was a female child, the third in a family of healthy children, born to healthy parents, and nourished entirely at its mother's breast. Up to the age of eight weeks the family had lived with friends at Washington, but they then removed to a house in Baltimore which, up to date three weeks before their arrival, had been inhabited by a woman who was attending the John Hopkins Dispensary on account of pulmonary phthisis; tubercle bacilli had frequently been found in her expectoration. That the infection of tuberculosis can cling for prolonged periods to rooms which have been occupied by patients suffering from tubercular phthisis is well known. When nine weeks old, this breast-fed infant of healthy parents began to live in a house thus infected; when less than four months old it was found to be suffering from fever and consolidation of the right lung. Its illness quickly ended in death, and the necropsy showed tuberculosis of the pleura on the right side, the middle and lower lobes of the right lung uniformly stuffed with tubercles; the spleen contained innumerable tubercles, the liver and kidney many. In connection with this the *British Medical Journal* very rightly says that such cases as the one here quoted afford striking evidence of the justice of the demand that some precautions should be taken to prevent one of the most common forms of tubercular infection. Two very striking examples of the infectiousness of phthisis came under my observation in my own practice at Brisbane in the last few months. In one case, which was observed at the same time by another medical man who arrived at the same conclusion, a gentleman contracted consumption from his wife who died of it some years ago. This case was all the more remarkable because inherited predisposition was absent in this case, no case of consumption having occurred previously in his family. The disease showed here some peculiarities, inasmuch as it progressed but very slowly, the otherwise healthy organism not prepared for the reception of the virus by inherited weakness resisting more strongly than it is usually the case. Another similar case is the following:—A young gentleman who was suffering from very far advanced tuberculosis of the lungs and of the throat was advised to go out to Queensland for his health, as usual being far too late to derive any benefit from the change of the climate. He came to Brisbane where he stayed with a cousin of his about 20 years old, with whom he was constantly together, driving out, eating at the same table, &c. About

four or five months after the gentleman had departed again, to die shortly after his arrival in England, his cousin began to lose flesh, to cough, and the expectoration exhibited tubercle bacilli on examination. Fortunately in this case, the evil being early discovered, could be arrested after a few months of treatment. The patient has gained flesh again, his cough has almost entirely disappeared, and he is doing generally very well. I should like also to mention the following interesting case that came under my observation:—Being directed by the Queensland Government to carry out experiments in order to inquire into the diagnostic value of Koch's lymph in cattle, I received for my experiments two bullocks which had been the leaders of a team. Both showed signs of evident tuberculosis; but when being killed it was found on *post mortem* examination that the disease of one bullock was of very old standing, as the extensions of the tubercular lesions and as the numerous deposits of lime salts proved, while the tuberculosis of the other bullock showed signs of comparatively more recent origin. The explanation is quite simple. These two bullocks had been together leaders of the team side by side for several years. One of the two bullocks either had had previously tuberculosis or contracted it afterwards. After some time also the other bullock got infected from the first one, being always close together with him. That he contracted it later than the first bullock the *post mortem* examination proved. I think that this case observed by me is the first instance of direct communication of the disease in cattle by breathing that has been noticed.

Now, the question naturally arises, why the contagion being present almost everywhere, not everyone gets infected with tuberculosis. The answer to this question is that healthy persons do not get infected as a rule by the tubercle bacilli, because the healthy organism has sufficient power of resistance. But wherever there is a weakened and impaired condition, either of the whole organism or of the organ that is being invaded by the tubercle bacilli, the latter have more chance of settling definitively in this organ. Very interesting experiments have been carried out by Cerhnheim. He inoculated the tuberculous virus to two rabbits, on one of whom he had previously made a venaesection. The animal which had suffered this loss of blood died soon of very fast-advancing phthisis, while the other one was still comparatively healthy, as the *post mortem* examination revealed. Further on, unsuitable nutrition and manner of living, over-

straining of the brain and of the body, especially during childhood, greatly conduce, by undermining the general state of health, to impair the resisting power of the whole system, and particularly of the lungs. Besides the deterioration of the whole system, nearly all affections of the respiratory organs offer a very favourable condition for the invasion of the bacillus. Bronchitis, catarrhal inflammation of the lungs, pleurisy, and other diseases, more particularly in children when recovering from measles and whooping-cough, are the preliminary complaints which but too often change into real consumption. But it must be always borne in mind that all those injuries inflicted upon the body are notable to produce consumption of the lungs by themselves; they only create a predisposition, an increased liability. A direct infection by the bacillus-tubercle must always take place before the fatal disease can set in.

2. The second way of tubercular infection is by direct inoculation. It is quite apparent that this mode of occurrence is more frequent in intentional experiments than in everyday life. I mention it here more for the sake of completeness than on account of its importance for public health. However, a few instances quoted might be of general interest, affording at the same time striking evidence of the danger of this minute form of vegetable life. Thernig reports a very interesting case of a servant who, quite healthy, cut her finger at a broken spittoon of her consumptive master. Some time afterwards she developed tuberculosis in the sheats of the sinew, and the axillary glands had to be extirpated on account of tubercular swelling. Dr. Gutzmann, at Berlin, contracted early last year, on a *post mortem* examination of a consumptive, a small wound on the finger, which did not heal for some weeks. On subsequent examination by Professor Ehrlich it was found that tubercular bacilli were present in the pus underneath the fingernail. Professor Koenig, of Goettingen, mentions a case where the use of a Praraz syringe for the injection of morphia produced localised tuberculosis in a patient because it had been used in a tubercular patient previously, and not properly cleansed. Lehman has observed 10 cases of inoculation tuberculosis in Jewish boys, caused "by sucking the wound after ritual circumcision by a phthisical person. Ten days after circumcision the wound became the seat of ulceration; four of the children died of tubercular meningitis, and three

died after a prolonged illness caused by multiple tubercular abscesses."

I think the above cases afford sufficient evidence of the danger of communication of tuberculosis by wounds; but to avoid it concerns more the surgeon than the general public.

The third way on which the tubercle bacillus attacks the human subject is, as above mentioned, by the alimentary canal by injestion with the food. It appears to me to be of very great importance, not only on account of the frequency of its occurrence, but especially because we are able to guard against it if proper precautions are taken. By the foregoing it has become apparent that in whatever organ the tubercle bacillus will be conveyed there might be the danger of infection, which takes place if the cells of the attacked organ do not offer sufficient resistance to the invading bacillus.

We therefore, *a priori*, expect that food containing originally tubercle bacillus, or mixed afterwards with material that contains them, will be a source of infection in the first place for the digestive organs. As an illustration of this reasoning I only wish to draw the attention to the frequent occurrence of tuberculous ulcerations of the bowels in phthisical patients in the later stages of the disease being caused undoubtedly by the continuous swallowing of the expectoration which abounds with tubercle bacilli. But where do we find tubercular infection of the digestive organs in healthy persons? Tuberculosis is not confined to the human race; it attacks nearly all the animals the flesh of which is used for human food, cattle especially being susceptible to the disease. The identity of the disease in human subjects and in cattle has first been vindicated by Professor Bollinger of Munich, and is now corroborated by most authors. The identity of the tubercle bacillus in cattle and in men in its anatomical and merphological characters; the identity of their peculiar susceptibility to aniline dyes; the identity of their appearance under the microscope; the identity of their growth on nutrient fluids, did not allow any other conclusion to be arrived at but that tuberculosis in cattle and tuberculosis in the human subject is one and the same disease. Moreover, it has been proved by numerous experiments that cattle can be made tuberculous by mixing expectoration of phthisical patients to their food, whereupon, as Noeard demonstrated, tuberculosis developed along the whole lining of mucous membrane of the digestive tract, thus showing

that tuberculosis might be transmitted from man to cattle. The direct proof for its occurrence in the opposite way is not forthcoming, simply because such an experiment, if carried out successfully, would be murder; but, to use the words of the *British Medical Journal*, the overwhelming bulk of testimony of scientists and experts is to the effect that in tuberculous cattle there lies a real danger to the human species. Flesh and milk from cattle most frequently convey the tuberculous contagion to mankind. The milk will be most likely contaminated if the disease is present in the udder of the cow. Meat derived from tuberculous animals might contain tubercle bacilli, but it is not absolutely necessary; it will greatly depend on the character and extension of the tubercular lesions. At a meeting of the Paris Académie de Médicine on March 3rd, Dr. A. Ollivier reports the following case:—At a boarding-school at Chartres a cow was kept, and its milk used for three years, when it was seized by the inspector on account of suspected tuberculosis and killed, when extensive tubercular lesions were found. During this time six pupils died of tuberculosis; six others showed evident signs of tubercular deposits, but recovered after being removed from the fatal place and kept for considerable periods in the country.

Under these circumstances we well understand why nearly every European country has enforced stringent rules of inspection. In France every carcase of a beast is totally condemned that shows the least signs of tuberculosis. Similar measures are enforced in Denmark. Germany condemns the whole carcase if the tubercular lesion is extensive; if the disease only affects one organ to a small extent the tuberculous parts are cut out, and the rest of the meat is sold, being officially labelled as inferior meat. I mention these facts only because they are likely to be of national importance for the different colonies of Australasia. Tuberculosis is prevalent in this part of the world as it is in the Old Country. I first showed its prevalence in Queensland cattle after the Royal Commission instituted a few years ago in Victoria had arrived at the same conclusion. Now, when we are trying to find a market for our surplus cattle in the European countries, we naturally must expect that these countries will deal not less leniently with foreign meat after subjecting the Home butter to rigid inspection. We therefore can hardly hope that these countries when dealing with Australian beef will be satisfied with anything short of their

own rules. American pork has been excluded from French and German ports because the inspection was declared to be unsatisfactory. We must be prepared to expect the same if we do not profit by the lesson, and start the most rigid inspection of all meat that leaves Australian ports.

5.—SOME OF THE DISEASES OF ANIMALS COMMUNICABLE TO MAN, OR COMMON TO BOTH.

By ARCHIBALD PARK, M.R.C.V.S.

In drawing attention to the necessity for more extensive research in investigating the above subject throughout the Australian Colonies, the obscurity of some diseases or their confusion with others has led to a great deal of misunderstanding among professional men, and the probability that legislation, at perhaps a date not far distant, may be asked to deal with some of those diseases in a stringent manner before their *real* or *assumed characters* are carefully investigated. The conditions in which many diseases exist in Australia is entirely different from Europe or England, where we take our cue from; for example, tuberculosis does not spread among cattle in Australia by *bad ventilation*, as in Europe, because our cattle are (millions of them) never housed. Our poultry contract tuberculosis that show the typical headed bacilli of the human subject. Turkeys seem to be specially liable to this form. Their habits are of a wandering nature, yet they seem to contract this disease without any trace of consumptive patients near their feeding places. "Actinomycosis" has long been confounded with cancer and tuberculosis, and although in many instances attacking human beings, is derived from the same source as cattle. Before the growth of the fungus can take place some primary lesion must exist to form a nidus for development of the organism.

Coccidium Oviforme,

A disease for the last thirty years confounded with tuberculosis, has within the last few years been found associated with "cancer," and is due to the presence of ovoid bodies belonging to the "protozoa." These parasites live in marshy places as well as in the animal body, and are especially numerous in the liver of rabbits. Water drawn from a source con-

taminated by this parasite to cleanse wounds would be a fertile source of propagating "cancer," accompanied by this protozoan, and offers an explanation why cancer is more prevalent in some districts than others. I have also found similar bodies in the liver of fresh-water fish taken from "Lake River," near Longford.

Diphtheria.

For the past seven or eight years I have had my attention directed to this disease during the early spring, at a time when the cows are in this colony calving in large numbers, and the prevalence of an eruption on the mammary gland of a highly contagious nature from cow to cow, and to milkers, should any abrasion or crack appear on the hand. This would be in some instances called "cow-pox," but the eruption appears in successive crops from week to week, on different parts of the gland and teats. In several instances where this eruption is prevalent diphtheria has also been virulent in the same neighbourhood. I have worked out, under the guidance of Dr. Klien, the cultivation of the diphtheritic bacillus, and seen animals affected with this eruption, that have been vaccinated with calf lymph three years previously in this colony, not proof against this disease.

Anthrax and Malignant Pustule

Are due to the bacillus antheris of animals, which is found in the blood as short rods, generally described as "square-cut ends." The rapidity with which these organisms multiply is so astonishing that death takes place in from 16 to 36 hours. Handling the carcase of an animal dead of anthrax with an abrasion on the skin is liable to produce malignant pustule, or "woolsorters' disease." During the outbreak of anthrax in Victoria in 1876, I pointed out this danger in a letter to the *Warrnambool Standard*, 26th April, 1876. It is a wide-spread disease, and fortunately M. Pasteur has been able to modify it by vaccination. We have a similar disease in sheep equally fatal, but the researches of Cornil, &c. have proved that it also can be prevented by vaccination. The disease alluded to is "Symptomatic Anthrax" or "Black Leg."

Glanders and Farcy.

Fortunately Australia is free from this loathsome and fatal disease, and it was only by a Resolution at the Stock Con-

ference being carried in 1889, imposing 14 days' quarantine on all horses other than Australian bred, we would to a certainty have had this disease imported by "Sell Brothers'" circus horses into New South Wales, and carried to every town of importance in Australasia, and its presence would not probably have been recognised until it had obtained a firm hold of the horse stock or some human beings in the colonies: the result would, it is needless to say, assuredly be fatal.

The illustrations of the diseases alluded to were prepared by Mr. C. J. Pound, whose services Professor Anderson Stuart has been fortunate to secure for the physiological laboratory in Sydney. The diagrams of actinomycosis, coccidium oviforme, and tuberculosis were drawn from Queensland, New South Wales, Victoria, and Tasmania, specimens procured by myself in the colonies named, where a large percentage of cattle are afflicted with the above diseases.

In concluding my remarks on the various subjects alluded to in this paper, I would suggest that an investigation of all diseases should be undertaken by experts specially qualified for such work. The training of the ordinary practitioner is not sufficient, nor is the time at his disposal to investigate outbreaks of disease available. To fully appreciate such services the Australian colonies must sooner or later provide means to prevent disease. The time has gone by when the medical practitioner was expected to cure, and the sanatory inspector to stamp out disease by disinfectants: relying on such remedies is only trusting to a sinking ship.

6.—PHYSICAL EDUCATION AND EXERCISE IN SCHOOL.

By MISS MACKENZIE.

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WITHIN the last few years the subject of education has received much attention, and even the word itself has assumed a wider and more extensive meaning. We are beginning to realise the inter-dependence of bodily and mental functions, and the necessity of a system that will conduce to the development of the whole child.

I have noted with interest that physical education has

received considerable attention at the late International Hygienic Congress in London, and a very able and interesting paper on this subject was contributed by Mr. George White, Chairman of the Committee on Physical Education for the School Board of London.

I think it will be readily admitted that in this important part of the education of our children we are very much behind England and the Continent, where for many years gymnasia have been attached to most of the schools and colleges.

In England the Education Department recognises the utility of apportioning some portion of the school-time to instruction in some form of physical exercise by allowing instruction in physical exercises and military drill to be included in the ordinary time-table of the school.

Here, on the contrary, few of our schools have done more for the physical culture of the pupils than to allow an hour once or twice a week after school hours for drill, calisthenics, or some other form of exercise, and it is left much to the individual taste of each child as to whether it shall take part in such exercise or not. Indeed a very strong prejudice exists in the minds of parents and teachers against gymnastics, especially for girls, from the mistaken idea that they conduce only to make athletes or acrobats. This idea arises from a misconception of the real aim and object of physical education.

Mr. George White says:—"The term physical education, used as denoting a subject for school instruction, has not such a wide meaning as when used generally. Its object in the former sense being partly to secure the best conditions for mental effort by promoting the best physical conditions, it includes such instruction as leads to uniform and harmonious development of the whole body of the individual child with due regard to his physical idiosyncrasies or any accidental or abnormal characteristics which may differentiate him from an ordinary generic child living under normal conditions.

The use of light dumb-bells in such exercises as shall bring all the muscles into action would seem to be very beneficial, supplying slight resistance without undue effort and consequent strain, such as frequently results from the use of heavy dumb-bells used for the special development of any one set of muscles. [A number of children here gave an illustrative example of light dumb-bell exercises].

It will be seen then that the object of physical exercises in

school is not to give powerful arms and shoulders, not to make athletes and acrobats, but, by free and well directed movements for all the muscles of the body, to promote healthy and vigorous growth, and to supply rest and diversion from intellectual toil.

This would be most effectually attained by introducing physical exercises into the ordinary school hours.

After an hour's mental effort the continual strain to fix the attention causes an amount of weariness to a young brain which a good teacher tries to relieve by change of work, say from geography or history to mathematics. A far greater amount of rest and fresh brain power would be derived by a change to physical exercises, bringing a fresh supply of oxygen to the lungs and consequently pure blood to the brain.

The body would be also materially benefited by the variety of posture and attitude after long sitting in constrained positions.

It is important that the exercises should be conducted by a thoroughly trained and efficient teacher, who must be competent to regulate them to suit the age and capacity of the pupils, with due regard to any inherent or acquired weakness in any individual.

The objection of teachers generally to any break in the ordinary school hours is that the attention is not readily regained, and that too much time is thus lost. This will be found not to apply where, during the time allotted to exercise, order and discipline are maintained, and habits of ready obedience, and attention to the commands of the teacher are enforced. It is very difficult for a teacher to know whether a pupil is giving full attention to a subject during mental work, but in physical work the slightest inattention can be instantly detected. Consequently drill and other well directed physical exercises are a mental and moral as well as a physical training, for they not only educate the body to perform certain movements and maintain certain positions, but also the mind to pay continual attention to what is said, and the spirit and will to render prompt obedience.

Probably no country has done more towards simplifying this form of culture than Sweden, and the Swedish system of "free exercises," requiring no fixed apparatus and bringing into play all the muscles of the body in a very brief space of time, while powerfully counteracting the injurious effect of long sitting in constrained and unnatural postures, is perhaps

best calculated to serve the purposes of rest and recreation in school. [Here the children gave an exhibition of "free exercises"].

It is impossible to over-rate the advantages to be gained by a systematic course of physical instruction, its result being, if properly carried out, not only to make children generally healthy and well developed, but to counteract any hereditary predisposition to disease which may be present, and this is most observable in the effect of those exercises specially designed for the expansion of the chest and shoulders.

Four, five, and six inches of increased chest measurement are often thus gained, and one pupil at the "ladies" gymnasium in Melbourne gained seven inches in six months. [Here the children gave an example of chest expansion movements].

It is frequently objected that children get sufficient exercise in out-of-door games and walking; but, while fully admitting the advantages of recreation pure and simple, and desiring that for girls especially more healthful and active games should be encouraged, I must draw attention to the fact that it is usually the healthy and strong children only who engage in active games and amusements. The object of physical education being hygienic, and not merely to promote athletic skill, we require as a supplement to games an organised system of exercises to be carried on simultaneously with the intellectual education of every child.

Open air exercise divides itself into three principal kinds—exercise which brings into nearly equal action all the muscles of the body—such as swimming. Exercise that gives considerable employment to the upper as well as the lower extremities—such are tennis, rowing, and cricket. Exercise which is chiefly performed by the lower limbs and trunk, and in which the muscles of the upper limbs are only auxiliary—such are riding and walking.

Swimming is perhaps the most valuable of all forms of exertion, as it brings every muscle into play, expands the chest, and in particular strengthens the back. In reference to swimming, Mr. George White says:—

"Its value as a subject of school instruction, and as a part of physical education, apart from the skill and bodily dexterity which it involves and the material advantage resulting therefrom, seems to me to be immeasurable. It affords a kind of counterpart of physical education on land, and no child can be said to have a complete physical education

until it has been taught how properly to use its limbs, and how to exercise all its muscles both in the water and out of it."

In these days, when the passing of examinations and the gaining of scholarships is made the one desirable attainment in school life for boys and girls alike, it is no uncommon occurrence for the successful candidate to leave school in a state of mental and physical collapse. The reason of this is not far to seek. The brain has been unduly taxed, while the bodily functions have been almost, if not entirely, neglected; every kind of healthy active exercise has been curtailed or altogether suspended, and physical education has formed no part of the prescribed course. If the exercise of the brain be excessive and beyond the point where the nutrition is equal to the waste, it will suffer in the same way and to the same extent as the other organs of the body.

May we not hope that the discussion of physical education at this meeting of the Australasian Science Association may lead to its recognition as an important part of our educational system and further its adoption in our public and private schools.

Education in its fullest and widest sense means the developing of the entire physical, intellectual, and spiritual capacities of the pupil.

Systematic exercise alone ensures the timely and harmonious growth which results in that highest physical beauty, symmetry of form; but systematic exercise conduces no less to the increased capacity of brain power, by furnishing a fresh supply of pure blood, and relieving the nervous strain brought about by continuous mental effort.

7.—AN INQUIRY INTO THE ADVANTAGES OF THE DOWNWARD SYSTEM OF VENTILATION.

By S. HURST SEAGER, A.R.I.B.A., *President of the Sydney Architectural Association.*

[*Abstract.*]

After referring to various systems of ventilation in vogue, the author went on to say:—

Now, I would ask you to note, that according to the accepted theory of the action of the upward system of ventilation, there must be a *downward movement of the fresh air* before its extraction, if the system is to be in any degree

successful. Thus, the fresh air must of necessity be rendered more or less impure by intermixture with the rising vitiated air before it reaches the occupants of the room. It must therefore be conceded that under ordinary circumstances it is impossible to ensure that the air breathed within a room shall be as pure as the source from which the fresh air is obtained. This has been admitted by such eminent authorities as Dr. Parkes and De Chaumont, who have also shown that in order to purify the vitiated air sufficiently to keep a room occupied by healthy people in a perfectly healthy condition 3000 cubic feet of fresh air must be admitted for each individual per hour. I have shown that a given quantity of air may be admitted and yet the room remain very imperfectly ventilated; there must, therefore, not only be the given quantity of fresh air, but means must be taken to ensure that it shall be admitted in such a way that perfect diffusion and intermixture with the vitiated air shall take place in all parts of the room, and this without any inconvenience to the occupants.

These conditions, I am of opinion, can only be fulfilled by making use of the essential factor in the upward system, viz., the downward movement of the fresh air. Between the ceiling and the level of the heads of the occupants of any room there is always a space equal to, and in most cases considerably larger than the space between that level and the floor, which can, without the slightest inconvenience, be made use of for purifying the warm vitiated air by intermixture with the cool fresh air as fast as it ascends from the lower level. This could not well be accomplished until the expedient was hit upon of placing an ordinary centrifugal fan *within the room* itself close to the ceiling, instead of placing the fan outside the room and forcing the air in through tubes. This difference makes it easily possible, as I have proved by personal experiments, to distribute the fresh air thoroughly to every part of the room without any perceptible draught; we need therefore have no doubts about the possibility of efficiently carrying out the downward system should it be determined that I am correct in thinking it desirable.

The best kind of fan to be used; the way in which it shall be worked; the best form of outlet, and all other details of execution may well be left for consideration at some future period.

Given, then, the possibility of admitting and thoroughly distributing the air at the ceiling level without inconvenience,

either by one or several fans according to the size of the room, are there any disadvantages outweighing the great advantage to be gained by its adoption?

The argument urged against the system that it is unscientific to bring down the impure air to be re-breathed is answered by the fact that the impure air is not brought down to the level of the occupants as such, for it is, as I have stated, purified by a thorough intermixture with fresh air near the ceiling level, so that when reaching the level of the occupants where it may be re-breathed it would be as pure as it is possible to obtain air in an enclosed and occupied space. We may therefore, I think, without error, affirm that in all cases of ventilation for healthy persons (leaving out of the question special ventilation required for noxious trades, infectious diseases, &c.) the air surrounding the occupants in a room ventilated by the downward system will be as pure, and there is a great probability of its being purer, than the air surrounding them in a room well ventilated by the upward system.

It may be put forward that it is a wasteful expenditure of energy to use the mechanical power in opposition to the natural upward movement of the warm vitiated air. There is, of course, a certain amount of power required to overcome this law, but even under the most extreme conditions the power that the heated air can exert is very slight as compared with that capable of being exerted by a good form of fan. A well constructed fan can be worked easily and economically so that it shall exert a pressure equal to two or three inches of water, while the pressure exerted by a column of warm air 80 feet high, at a temperature of 70° Fahr., and with the external air at 32° Fahr. is, by the formula—

$$\frac{T - t \times H}{491} = P$$

Where T = Temperature of warm air.
t = Temperature of cold air.
H = Height of column.
P = Pressure or head.

$$\text{Hence } \frac{70 - 32 \times 80}{491} = \frac{3040}{491} = 6 \cdot 2$$

And to obtain the velocity due to this head we have $8\sqrt{P} = V$, where V equals the velocity in feet per second. Thus, $8\sqrt{6 \cdot 2} = 8 \times 2 \cdot 5 = 20$ feet, a velocity which gives, according to Hutton's experiments, a pressure in inches of water of ·1446.

This, with more unfavourable conditions than can ever obtain in domestic ventilation, and only rarely in the case of public buildings; for it is but seldom our halls are 80 feet in height, and they are rarely in New South Wales surrounded by an atmosphere at a temperature of 32° Fahr.: yet under these circumstances fans working with the easily obtained pressures of from two to three inches of water only have about one-sixteenth to one-twentieth of their power employed in overcoming that of the heated air. But in winter, when the room has to be heated by artificial means, there is a decided advantage in the downward system; for the means of warming adopted universally in this country is the open fireplace, which forms a most powerful exhaust at the floor level, just where the system requires it, and we thus have in the open fireplace a most valuable help towards efficient ventilation, both fire and fan mutually assisting one another in accomplishing the work that has to be done.

Very different is it when a fire is burning in a room ventilated by the upward system of ventilation; we then have the ludicrous spectacle of the ventilator pulling the air at the ceiling, and the fire at the floor level—acting one against the other to the detriment of both, and the great inconvenience of the occupants.

Another point in favour of the downward system is that in summer when the air in the room is naturally cooler (and should for comfort be kept cooler), and therefore of greater specific gravity than the external air, the natural movement is downwards, and the mechanical power is then employed only in assisting the natural laws.

The downward system would also prevent, to a considerable extent, any inconvenience being felt from draughts through crevices round doors and windows during strong winds: for the pressure exerted by the fan would, under all ordinary conditions, tend to force the air of the room outwards through the crevices. The great discomfort experienced by all who have had the misfortune to sit near a door in a crowded hall on a cold night would also be avoided, for just as in the upward system the air chooses the path of least resistance into the hall through the open door, so it would choose the same path in going out in preference to passing through the outlets provided at the floor level when the air is supplied at the ceiling level; and the air which would thus pass out being of the same temperature as the air of the room, no inconvenience would be created; for the same reason no

inconvenience would arise from the exit of the air at the outlets provided at the floor level.

The possibilities of cooling, warming, moistening, drying, screening, or medicating the incoming air are of course as great when the air is forced in at the ceiling as when forced in at any other part, but for all these purposes the downward system presents the advantage of greater certainty of action for the same reason as for the purpose of prevention of draught.

The advantages, therefore, which the downward system presents when the fresh air is forced in by a centrifugal fan at the ceiling level are, it appears to me:—

1st. A perfect diffusion of the fresh air to all parts of the room.

2nd. A complete changing of the air of the room without inconvenience to the occupants.

3rd. A considerable lessening of the inconvenience and danger arising from draughts.

4th. A certainty of action in regard to the preparation of the fresh air to suit the comfort of the occupants.

5th. A system in harmony with the existing mode of warming and ventilating by means of the open fireplace.

6th. A system in harmony with the natural laws operating during the summer months when perfect ventilation is most urgently needed.

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8.—THE SEWERAGE OF A SEASIDE TOWN.

By A. MAULT,

Engineering Inspector to the Central Board of Health of Tasmania; one of the Vice-Presidents of the Engineering Section of the Seventh International Congress of Hygiene and Demography, London, 1891.

THE system of sewerage to be recommended for adoption at any place naturally very much depends upon its circumstances. And one of the most important of the circumstances that affect the decision to be come to in the matter is that of the position and relation of the place with respect to the natural outfall of its sewage. If the outfall of an inland town be into a river that, further down in its course, is the source of the water supply of a district, a system must be adopted that will not interfere with the purity of that supply. If the town be on the seaside, at a place where there is a

good outfall at a point where there are sets of currents that carry everything out to sea, advantage may be taken of such a circumstance to avoid all expense of sewage treatment by discharging it directly into the water. If, again, the town be on a beach, or on a tidal river, where the ebb and flow of tide are such as to retain for a time, floating up and down, the matters thrown into it, with a tendency probably to deposit them upon the shore, it is clear that in most cases it would not be advisable to discharge sewage directly into the water without some treatment that would prevent nuisance arising therein from the action of the tide, and, particularly, that would prevent the deposit of noxious matters on the beaches. It is equally clear also that, as the water into which the discharge takes place, being salt, cannot be used as a source of supply for domestic consumption, the treatment of the sewage, while it should effect the preventive measures just referred to, need not be of the nature necessary to secure the chemical purity that should be required in the case of the inland town and the fresh-water river. As most of our large colonial cities have arms of the sea or tidal rivers as the natural outlets of their sewage, I propose, as a matter of practical hygiene, to discuss the system of sewerage to be recommended for their adoption, and to do so in the light of comparatively recent developments of sanitary science as applied to such work.

As I have approached my subject from the consideration of the dominant circumstance of outfall as affecting the adoption of one or other of various systems of sewerage, I shall begin by considering sewage disposal—that is, the work done at the outfall—and afterwards take up the matter of sewage collection. It may be thought by some that this will be working backwards, as you must collect your sewage before you can dispose of it; but, on due thought, it will be found that though sewage collection has only a very limited bearing upon its disposal, the method of its disposal may have a very great influence upon most of the details even of the system of its collection—that is to say, upon the details of the construction of the sewers.

This disposal is, as above described, based on the supposition that the sewage is to be discharged into the sea or a tidal river, and that, preparatory to that discharge, it is only necessary to partially purify it. This partial purification especially in the case of a comparatively large city situated upon a comparatively small tidal river, should be sufficient,

not only to prevent the floating about of solid obnoxious matter, and its deposit upon the foreshore, or its settling at the bottom of the water in places where it may reappear later on in the form of mud-banks, left bare at every tide, but the effluent sewage should also be deprived of its putrefactive capabilities, so that there shall be no disengagement of noxious gas from it in case a large body of it should be left stagnant for a time—say, at low water. This purification cannot be effected by the lime processes of precipitation, as, though they fulfil the requirement of rendering the effluent clear enough, they do not render it imputrescible. What is required is a process that will thoroughly oxidize the organic matters of the effluent, and this the lime processes do not do. As far as the really practicable is concerned, I believe we are confined, for the proper effecting of this oxidation, to either, first, filtration by earth in the way of percolation or of surface irrigation, or, secondly, to some iron process.

First, as to filtration by earth. The adoption of this system requires the obtaining of a sewage farm with a suitable soil, and of an area of about one acre to each 100 of the population. In this provision of land, as well as in all other matters connected with sewage disposal on this system, enough land must be obtained, not only for the immediate present, but also for the requirements of a more or less definite future. As this land should be at a distance from the habitations of the people, an irrigation farm entails the necessity of a great length of outfall sewer; and as it is cheaper to construct one sewer of sufficient carrying capacity than several sewers which shall collectively have that capacity, this outfall sewer must be a comparatively large one; and all the more so in anticipation of the future. Moreover, as a seaside city is, in some of its parts at least, a low-lying city, it is inevitable that some of its sewage, if not all, will have to be raised by steam power from a lower to a higher level. To economise the cost of this power it is usual to limit this lift to the smallest height that will secure the flow of the sewage by gravitation on to the farm—a limitation that tells upon the size of the outfall sewer as it tells upon its gradient, for it naturally takes a larger sewer to convey a given quantity of sewage in a given time at the slow rate of a flat gradient than at the quick rate of a steeper gradient.

The effect of all these influences upon the economical aspect of the system of sewerage is not confined to the size

and length of the outfall sewer, for the same considerations often render it desirable to lay large collecting sewers at a great depth—through the ridges, for instance, that divide different drainage basins—so as to bring all the sewage to one place to be pumped. The effect of them upon the hygienic aspect of the system will be shown by the fact that large sewers mean largely increased capability and probability of producing sewer gas, and largely increased capacity for holding it, at the same time as largely increased difficulty of effecting any remedial ventilation or any remedial cleansing by flushing. The capacity of a sewer has to be calculated upon the maximum quantity of sewage it will reasonably have to provide for. The usual practice of engineers is to limit this provision to four times the maximum quantity of house sewage properly so called, and thus allow for the rainfall upon houses and yards that cannot be conveniently and economically separated from the house slops. Thus, in London, Sir J. Bazalgette provided for 106 million gallons of sewage and 324 million gallons of rain-water a day; and at Melbourne, in his report to the Royal Commission, Mr. Thwaites proposed to provide, in his sewerage scheme for that city, for 42 million gallons of sewage and 120 million gallons of rain-water. The consequence of making this provision for rain-water, and it should be made, is this:—The minimum quantity of sewage passes through the sewers in hot, dry weather, that is, when there is no rain; and consequently at that time, even at the hour of the day when most sewage passes, the sewers are only quarter full, all the rest of the space in them being occupied with sewage-tainted air, all the more tainted as the slowly-flowing sewage is the longer subject to the heated atmosphere. For this hot, dry weather is just the time when the sewage naturally gives off most of this tainted air, so that the larger the sewer the larger the volume of sewer gas, and the longer the time it has in which to develop itself; and furthermore, as the larger a sewer is the greater is the difficulty of ventilating it, this larger volume of sewer gas is all the more difficult to dilute, and therefore when it is forced into houses, or into the open air of streets and courts, it is all the more poisonous.

To illustrate what I mean, let us take a 10-feet barrel sewer laid with a fall of 1 in 3000, as being necessary to carry the sewage of a town to a sewage farm—(one of the proposed outfall sewers at Melbourne is 11 feet 3 inches in

diameter, with a fall of 1 in 3100). To secure this gradient the sewer will probably have to be laid at considerable depths under the surface. (Mr. Mansergh proposed to construct one part of his sewer at depths varying from 62 to 28 feet, and the other part at a maximum depth of 86 feet below the surface). Now, if to carry out some other system of sewage disposal a gradient of 1 in 100 could be obtained, the same quantity of sewage could be carried by a 5-feet barrel sewer; and if this other system did not divert the sewage from its natural outfall, it is probable that the better gradient could be obtained with a sewer laid at a comparatively small depth. If this were so, two benefits would result: in the first place, the economic benefit of the saving in the cost of the construction of a small sewer at a shallow depth instead of a large sewer at a great depth; and in the second place, the hygienic benefit of having a more easily flushed and more easily ventilated sewer, and one which is not so capable of generating and storing sewer gas. For in hot dry weather the larger sewer when compared with the smaller exposes about double the surface of sewage to the air for four times longer a period wherein to develop putrefaction; has about four times the storage capacity for the foul air generated; is at least four times more difficult to ventilate; and requires at least four times the quantity of water to flush it—a quantity which in sewers of large size is really prohibitive. All these observations in reference to the main outfall sewer apply with almost equal force to the main collecting sewers, one of which, for instance, in Mr. Mansergh's scheme is 14 feet in diameter, and laid at a great depth, and as it is larger than the outfall sewer I presume it is laid at a still flatter gradient.

On the other hand, a sewage farm for treating the sewage of a city before its discharge into the sea has the advantage of sufficiently purifying it and disposing of it at one operation; for the irrigating process will have left the solid part of the sewage on or in the land, whereas a chemical process leaves this solid part in the form of sludge in a tank, whence it has to be lifted and got rid of by a second operation. I may say at once that I do not mean to claim for a sewage farm the additional advantage that it not only disposes of the sewage but disposes of it by utilizing it; for, as far as our experience in England and the Colonies is concerned, this utilization is only productive of increased cost in the disposal: that is, every pound gained in a year by a sewage

farm is gained by a yearly expenditure of more than a pound either in labour or in interest upon capital expended. All that can be claimed is, that when the sewage is delivered on a farm it can be disposed of in a satisfactory manner that will not be costly, provided that the farm be well managed, and that the effluent water can be discharged into the sea. At present it has never paid for the cost of taking the sewage upon the farm.

To resume: it is necessary for, or commonly incidental to, a system for the disposal of the sewage of a seaside or tidal river-side town by filtration over or through land to provide for the following economical details, not only for the present, but for a future also :—

1st. To secure a suitable farm of sufficient area at a distance from population.
2nd. To construct a long outfall sewer.
3rd. To pump all or the greater part of the sewage.
4th. To give the outfall sewer a flat gradient, and consequentially to make it a large one, and probably a deep one, in order to reduce the cost of this pumping by lessening, as far as practicable, the height of the lift.

And to face the following sanitary difficulties, which are the results of the above-named details :—

5th. The difficulty of keeping the sewers clean ; and
6th. The difficulty of ventilating the sewers.

Of course, the resolution of these difficulties is an economic detail also. And I have pointed out that these details and difficulties affect the main collecting sewers as well as the main outfall sewer.

Before I go further, I should now call your attention to a matter connected with the sanitation of all towns—seaside and inland—and that is, the disposal of its dry refuse, whether collected from streets or houses; for this is a matter that has special relation to the 3rd of the economical details above alluded to—the pumping of the sewage. Wherever I have been in Great Britain I have found that where the street and house refuse have been burnt in properly constructed furnaces, their combustion, without that of any other fuel, has yielded sufficient heat to generate all the steam that would be required to pump, part at least, of the sewage of the town to the limited height that would probably be necessary. This, of course, is an important consideration in connexion with

the cost of the pumping, because, as the refuse must be collected and disposed of, and as it is universally admitted that, in reference to a considerable part of it, burning is the only proper disposal, and should be done whether the heat produced by such burning be utilized or not, the steam produced may be said to cost nothing in the way of fuel.

We are now in a position to consider what I have said I thought to be the only other practicable way of sufficiently purifying the sewage before discharge in the case of a seaside town—that is, by some iron process. One of these processes —Electrolysis—is based on the oxidation of the organic matter in the sewage by the electric current acting on iron plates placed in shoots leading from the sewers into the settling-tanks, and so arranged that all the sewage must come into contact with the iron dissolved from the plates. This iron in precipitating, as ferric oxide, mechanically carries down with it the suspended matters, and at the same time gives off oxygen to the organic matters in solution. The result is, that after the precipitation has taken place the water is free from suspended matters, and has lost from 57 to 87 per cent. of the albumenoid ammonia the sewage contained—a degree of purity that is quite sufficient for a tidal river, as the electrolytic action has also rendered the water practically imputrescible. I suppose that after the experiments on a large scale, made by Mr. Webster, the inventor of the process, at Crossness, with the London sewage, we must consider that electrolysis has entered into its practicable stage. But I will not occupy time by further consideration of it, as there is another iron process that practically has the same effect, from analagous action, and at a very much less cost.

This other process consists in the employment of ferozone as a precipitant and purifier of the sewage. According to an analysis made by Sir Henry Roscoe, ferozone consists of—

Ferrous sulphate	26·64
Aluminium sulphate	2·19
Calcium sulphate	3·30
Magnesium sulphate	5·17
Combined water	8·20
Moisture	24·14
Silica	11·35
Magnetic oxide of iron	19·01
	100·00

Dr. Arthur Angell, the County Analyst for Hampshire, speaks thus of it:—

"Ferozone contains a large proportion of ferrous iron salts, and for that reason alone cannot fail to be a powerful chemical disinfectant; further than this, however, it contains salts of alumina and of magnesia, both of which assist as decolorants and precipitants. The remaining part of ferozone is made up principally of very finely divided porous magnetic oxide of iron, and this serves both as a further oxidising agent and as a weighting material, which accelerates the subsidence of the suspended matter, and keeps the sludge down as it accumulates at the bottom of the tank.

"The insoluble portion of the ferozone is composed of finely-powdered polarite—a newly-invented material, to which the filter-beds containing it owe their very remarkable oxidising powers; this powder, therefore, keeps the sludge sweet during subsequent disposal, either by pressing or drying, or by both; and thus a part of the process, which is so offensive at sewage works where lime forms one of the ingredients used, is carried on without committing a nuisance."

I have seen ferozone used in several places, and always with satisfactory results. At Southampton, a seaside town with over 60,000 inhabitants, it is used for the treatment of the greater part of the sewage in the following manner:—

On the Town Quay, close by the Town Pier, in a publicly frequented place, there are built two covered precipitating tanks or reservoirs, each of which is capable of holding more than 360,000 gallons of sewage, and which are used alternately,—the two together being large enough for treating the whole sewage of the town. They are at the outlet of a main sewer; and upon this main sewer, at about 50 yards before it arrives at the tanks, is an ordinary man-hole in the street, and close by is a small cottage used as a store for the ferozone. In this store the ferozone is slightly moistened with water, to which a little sulphuric acid is added,—the dosage being one pound of acid to the hundred-weight of the precipitate. In the man-hole a perforated box is slung down into the sewer, so that the bottom of it is always in the stream of sewage. The ferozone is sent into the box by means of a shoot from the top of the man-hole, three charges a day being sufficient. The quantity used is not quite 9 cwt. to a million gallons, costing at Southampton about sixteen shillings. The perforations in the box are so arranged as to allow the varying quantity of sewage to wash out the proper quantity of the precipitant,

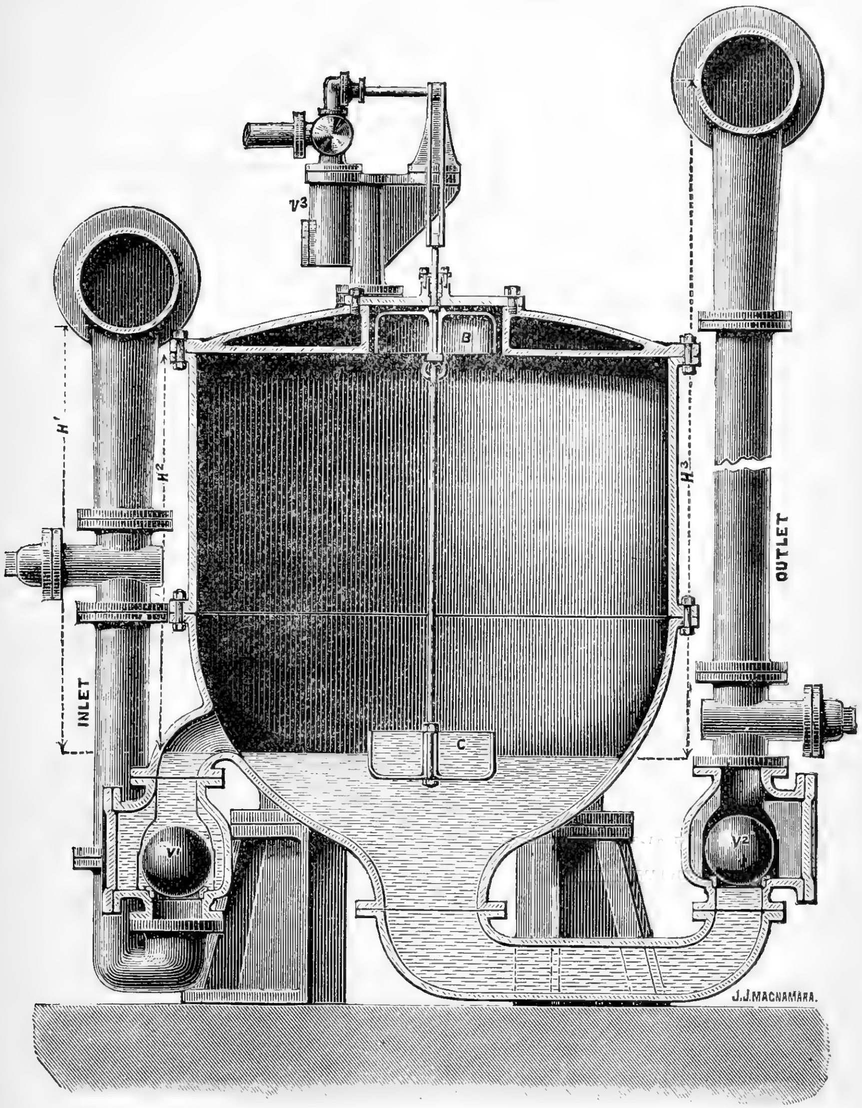
In the 50 yards flow from the man-hole to the tanks the sewage and ferozone get well mixed together. The sewage in the tanks may be said to be always stagnant, that is, in the condition favourable to sedimentation; for, as the sewage pours out of a comparatively small sewer into a tank 100 feet long by 60 feet wide, its rise in the latter is a very slow motion. When one tank is full the sewage from the sewer is turned into the other, which has been emptied to receive it. The full tank is allowed to stand for two hours longer, at the end of which time the water has become clear. As the top water is naturally the clearest, in emptying the tank the water is always drawn off from the top by a well known arrangement. If the state of the tide permit, the whole tank is emptied by gravitation. If the height of the tide does not permit this, the water that cannot be so discharged is discharged by one of Shone's ejectors; and there is a special arrangement to prevent it from discharging any of the precipitated mud—the sludge—with the water. This effluent water is superior in purity to the effluent from the electrolytic process, for not only is all the suspended matter in the sewage precipitated, but with it 90 per cent. of the dissolved organic matter, as compared with the before-mentioned 57 to 80 per cent. It is also superior in purity to the effluent waters from the sewage farms at Croydon and at Adelaide, according to analyses kindly given to me by the engineers-in-charge, Mr. Walker, the Borough Engineer of Croydon, and Mr. Bayer, the Sanitary Engineer to the Government of South Australia. And furthermore, this effluent water is deprived of its liability to putrefy. I saw samples that had been kept for months showing no signs of putrescence.

I take it that I have thus shown how the watery part of the sewage may be, and is, satisfactorily disposed of without possibility of creating a nuisance in a tidal river or the sea. There is nothing left in it to be deposited on the shores, or to form mud-banks; and if pools of it are left stagnant they will not ferment and make bad smells. The more solid part, the sludge, has still to be dealt with; and, in the first place, it has to be got out of the bottom of the precipitating tanks. As in describing how this should be done I have again to refer to Shone's ejectors, I will make a little digression about them, as from current talk, even among people who profess to know all about them, their capabilities are but little understood, and they are considered as part of Messrs. Shone and Ault's Hydro-Pneumatic Sewage System, and nothing else.

Like all other engineers, Messrs. Shone and Ault have carried out sewerage works on their own particular system ; but no one knows better than themselves that the ejector, upon the use of which their special system—and it is an admirable system—is based, is capable of rendering great service in connexion with other systems. So it is altogether foolish and misleading to speak of the use of the ejector as implying the adoption of the Hydro-Pneumatic System for the whole of the sewage, or as if the ejector were simply intended as a sewage-pumping machine. At Southampton its chief use is to lift the sludge from the precipitating tanks and deliver it through a 4-inch iron pipe to the manure works, which are in one instance a mile, and in another instance $2\frac{1}{2}$ miles from the tanks. At Warrington an ejector in like manner sends the nightsoil collected from the pails in the town to the manure works in the suburbs.

To those who have not seen the ejector at work the accompanying drawing, showing one in section, may give some aid in understanding its action. It is usually placed in a brick chamber under the tank or sewer in connexion with which it is to work. The communication from the tank or sewer to the ejector is shewn on the left hand side, and from it an iron pipe marked "inlet" delivers the sewage or sludge by gravitation into the ejector, which consequently must be placed sufficiently below the level of the sewer or tank to allow the sewage or sludge to rise to the top as high as the bell marked (B), and to do this it raises the ball-valve (v^1) on the inlet pipe. The bell (B) and the cup (C) are both fixed on a spindle, the rising and falling of which works the slide-valve of the automatic gearing connected with the compressed air main. The slide-valve box is marked (v^3), and the compressed air-pipe is shewn coming into it from the left. When the sewage or sludge rises in the ejector up to the bell (B), the atmospheric air in the bell is enclosed, and as the sewage or sludge still rises it raises the bell and its spindle sufficiently to shift the slide-valve and allow the compressed air to pass through the opened ports on to the surface of the sewage or sludge in the ejector. The amount of compression given to this air is, of course, dependent on the duty it has to do, so if it be necessary to lift the sewage or sludge a considerable height, or to force it along a considerable length of main, a corresponding degree of compression has to be given. Immediately the compressed air acts on the surface of the sewage or sludge the

pressure shuts down the inlet valve (v^1)—preventing the sewage or sludge from returning into the sewer or tank—and opens the outlet valve (v^2), and forces all the contents of the ejector through the outlet main. When the level of the sewage or sludge is thus reduced below the level of the cup (C), the weight of the liquid therein is sufficient to pull down the spindle and reverse the action of the slide-valve. This first cuts off the supply of compressed air, and then allows that in the ejector to exhaust down to atmospheric pressure. The weight of the sewage or sludge in the outlet pipe then closes down valve (v^2), and that of the sewage or sludge in the inlet pipe opens valve (v^1), and the whole operation recommences, and continues as long as there is sewage or sludge to flow and compressed air to act.



It will be seen that the action is entirely automatic as far as the ejector is concerned; the machinery is very simple and not likely to get out of order, nearly all the parts actually

coming into contact with sludge or sewage being the hard skin of the castings, which are coated with Dr. Angus Smith s composition. Compressed air is for the present the best practical means of transmitting such force as is here required to a distance, and among the great incidental advantages of its adoption in connexion with Shone's ejectors are the facts that the works for generating the power may be placed wherever most convenient and almost without reference to where it is to be employed, and that the multiplication of ejector stations does not entail a corresponding multiplication of expenses. They have, furthermore, stood the test of experience.

At Eastbourne eight ejectors are used for sewage-lifting, with two miles of iron mains for the compressed air, and some of these have been in use for ten years. The Chairman of the Drainage Committee of the Borough says, in an official report:—

"The air pipes are laid under the streets, and we have never had the least trouble with them, and the observations taken from time to time show that the loss by leakage and friction is practically nil. The ejectors and the automatic gear are strong and simple in construction, and they work in their chambers under the streets noiselessly and innocuously, and need little or no repair or personal attendance."

To sum up my observations upon the Shone ejector, I may say that every sanitary engineer whom I met who had had practical experience of it was perfectly satisfied with its working, not only as efficient when dealing with small quantities in little districts and in exceptional circumstances, but as being capable of application to efficiently and economically collect and discharge the sewage, both solid and liquid, of the largest cities.

After this digression, I get back to the consideration of the sludge left after the disposal of the clarified water. At Southampton the precipitating tanks have been built with dished floors sloping sufficiently to enable the sludge to flow by gravitation to the outlets communicating with a Shone's ejector, which, as I have above mentioned, sends it through a 4-inch main to the manure works at the Corporation yard a mile or two away.

As I have now done with what takes place at the Town Quay precipitating works, I may mention that it is all done without creating any nuisance, the ferozone acting as a perfect deodorant, as noted above in the extract from Dr. Angell.

The disposal of the sludge is the most difficult matter to be satisfactorily dealt with in connexion with chemical treatment of sewage. Pressing it into dry cakes for sale as manure is a delusion and a snare. The most valuable manurial part of the sludge is still in solution, and the pressing out of the water consequently sends out with it the ammonia and soluble phosphates, and so the remaining cake is not worth the cost of pressing; and, to complete the folly of the whole proceeding, the concentrated manure in the expressed water is returned to the tanks to be treated over again—that is, to be re-diluted and re-concentrated. At Southampton the sludge used to be burnt in the destructor, but is now mixed with street sweepings and sold readily as manure. At Birmingham the sludge is also profitably utilised by being spread over land and then dug in. At London it is sent out to deep sea in tank ships. At Ealing it is burnt. At every other place I know it is accumulating and growing to the dimensions of a "serious difficulty." It goes without saying that if there is a market for it as at Southampton, or land for it without expense of carriage, as at Birmingham, the sludge should be utilised; but as I do not think the one or the other is likely to be obtained in the colonies in the case of the larger cities, I should in their case recommend the disposal of it by burning it in the destructors that must necessarily be built for scavenging purposes. This can be done without nuisance, as everyone knows who has had any experience with destructors. If it be objected that this is wasting manure, I would reply, Let anyone who objects to the waste take the manure and use it. And I would go further, to encourage him to take it—I would give him what it would cost to burn it. It will be understood that with ejectors there is no necessity to place the destructors close to the tanks, but that they can be placed wherever most convenient in relation to town refuse disposal.

I have now brought the matter with reference to sewage treatment by ferozone to the same stage that I arrived at with reference to its treatment by irrigation, and can thus resume what is necessary for, or commonly incidental to, a system for the disposal of the sewage of a seaside town by this precipitating process:—

1st. To provide covered tanks sufficiently large to treat the whole sewage.

2nd. To provide a sufficient quantity of the precipitant.

3rd. To provide means for discharging the effluent at all states of the tide.

4th. To provide means for dealing with the sludge.

Now, if we compare these necessary, and these probably necessary, provisions to be made in order to carry out the precipitation process with the necessary and probably necessary provisions to be made in order to carry out an irrigation scheme, we shall be able to make some calculation as to the relative cost of the carrying out and of the yearly working of the two systems. I must premise that I take the case of Melbourne to base this calculation upon, as in Mr. Mansergh's report there are the needed estimates of cost as regards his irrigation scheme. I should further premise that I take the part of his scheme that is to be first carried out as being based on actual present requirements for pumping, sewer construction, &c., with a certain provision for the future, but not the full provision of his complete scheme—though this latter would have shewn a still greater divergence between the relative cost of the two systems. I should also say that, as in the smaller scheme the expenditure at the pumping works is reduced by two-thirds, I presume the quantity of sewage to be pumped is to be equally reduced.

Three of the necessary provisions for an irrigation scheme were shewn to be the farms, the outfall sewers, and pumping power. Mr. Mansergh's estimate for the farms

is	£312,000
For the outfall sewers	1,333,000
For so much of the pumping stations as is to be now done	219,000
For the proportionate share of the contingencies upon the above	186,000
Making a total for the work exclusively needed for the disposal of the sewage...	£2,050,000

The yearly cost of the system on Mr. Mansergh's estimate would be—	
Repayment of capital and interest on above amount	£87,400
Proportion of wages, staff, &c.; also half-cost of work at pumping stations	11,100
Total yearly cost	£98,500

With regard to the cost of making the necessary provisions for carrying out the system of sewage disposal by the precipitation process I have described, I have got no such details as Mr. Mansergh's Report furnishes with respect to his irrigation scheme; and as I have not the time at my disposal to get out such details for myself, I base my calculations upon the experience of Southampton, and offer them, not as exact, but as showing—after a very large allowance is made for errors—that precipitation by ferozone is a system worth considering.

The three necessities, as far as capital expenditure is concerned, that are required for this system, are—the tanks, means of discharging the effluent, and means for dealing with the sludge. I cannot separate the expenditure at Southampton upon tanks from that upon the ejectors and the machinery; but, taking the Melbourne sewage to amount to 42 million gallons a day, the necessary tanks and machinery of all sorts, and air and sludge mains, would cost (being 20 times the cost at Southampton) £600,000

To burn the sludge would require 80 additional destructor cells at a cost of	32,000
Making a total capital outlay of................	£632,000

The yearly charges would be—

Repayment of capital and interest	£26,950
Work at tanks and destructors, and superintendence (being 20 times the cost at Southampton)	5730
Ferozone, 6900 tons, at 60*s*.	20,700
Making a total yearly charge of	£53,380

It will be noticed that, in connection with the yearly cost of pumping for Mr. Mansergh's scheme, I have only taken half what he allows, as I think, even with his machinery, the other half might be saved by utilising the steam-generating power of destructors.

Now these figures show, with the reservation I have made, that the necessary expenditure for the sewage disposal works of Melbourne, as distinct from sewage collection, will be £2,050,000 for doing it by irrigation, against £632,000 for doing it by precipitation,—a difference in favour of the latter of over £1,400,000. The yearly cost of the irrigation

scheme would be £98,500, against £53,380 for the precipitation one,—a difference of over £45,000 a year in favour of the latter.

Nor is this all. As I have before remarked, the method of sewage disposal affects the methods of its collection. At Melbourne the necessity of having a single pumping station for the eastern outfall involved the necessity of having enormously large and very deep collector main sewers leading to it. If these sewers could discharge, after precipitation treatment, at any convenient outlet on the Yarra and other streams (and provision is made for this in the other scheme), it is manifest that these sewers could be greatly reduced in size and in depth, and probably half, and certainly a third, of their cost could be saved. This would make the total cost of the irrigation scheme £2,670,000, being more than two millions in excess of the other; and the yearly expenses £125,000, being nearly £72,000 a year more than the precipitation scheme.

So much for the economical aspect of the two systems. If we consider another aspect—the hygienic—we shall find the advantages are also on the side of the precipitation scheme. I have already pointed out the dangers arising from allowing sewage time to ferment while slowly flowing through immense sewers laid at flat gradients. And when the sewage arrived at the farm, it would have to be differently managed than any sewage farm I ever saw—and I have seen a great number—if the irrigation did not create some nuisance. But with the precipitation system no nuisance need arise anywhere. The sewage would quickly arrive—and consequently arrive while quite fresh—at the mixing-tanks, where it would be rendered, practically speaking, imputrescible. The mud precipitated need not be exposed nor touched until it forms part of the clinker drawn from the furnaces.

Again, with regard to the carrying out and practical working of the two systems, the advantages are all in favour of a precipitation scheme with several outfalls. In the first place, it has a capacity of adaptation that the irrigation scheme has not. For instance, if on the morrow of the completion of some such collection system as I have roughly sketched out, the electrolytic system were so far perfected as to render its adoption desirable, every part of the work done would be immediately available: and so with other systems of treatment. Take even the extreme case of having after

all to adopt an irrigation system, nothing would have been lost, for the money that the farm and its adaptation the outfall sewers, and the pumping stations and machinery would cost would be still available, as it would not have been spent; and the money that had been spent on precipitating tanks would have been saved in sewer construction. On the other hand, the adoption of the irrigation scheme involves permanent committal to it, as, notwithstanding any advance whatever that hygienic science might make as regards sewage disposal, no change could be made without sacrificing enormously costly works.

And this brings me to another practical disadvantage of the irrigation system. Not only are the farms, the outfall sewers, and the pumping stations special requirements for this system, and, at least in great part, useless for any other, but the two millions they are to cost must be spent before anything else can practically be done. For you must begin your sewers from their outfall. Thus, not only must the most questionable part of the expenditure be first made, but the commencement of all the rest of the work must be delayed until it is made. On the other hand, if the precipitation system were adopted each district might begin its work at once, and the whole work of actual house-drainage might be completed before it could be commenced with the irrigation scheme.

It has been objected that the use of the ejector system entails liability to a great disaster in case of accident to the pipes or machinery—disaster in the shape of sewage-flooded cellars, and so on. This may be true in the case of a sewerage system based entirely on sewage-lifting by the ejectors in parts of a district at a distance from a natural outfall. But the system I have recommended is not based on such dependence upon the ejectors. The ejectors would be employed to do specific work, and their failure to do it would not involve anything more than the discharge of sewage for a time without purification—nothing like so serious a disaster as the failure of the machinery at a pumping station such as those proposed for Melbourne.

In conclusion, I wish to repeat that I do not pretend that the calculations I have made to illustrate the financial result of adopting the precipitation system at Melbourne are anything but rough approximations. I have not the time, nor is it my duty, to make the detailed examination necessary to arrive at exact figures. I took Melbourne as my illustration

for various reasons: its sewerage is the largest unresolved problem of the kind in our midst, and consequently the most important from a hygienic point of view. Though I suppose the authorities here are too far committed to re-open the consideration o the matter, that should not prevent its discussion or take it out of the sphere of the criticism of the Hygienic Section of this Association. Again, the estimates for what is proposed to be done are all ready to hand, and it was only because this was the case that I could find time to consider them. There are no such figures available for Hobart. But I have not tried by speaking of Melbourne to set forth in detail what I think should be done here. I think that though there are broad principles that are applicable to all seaside cities, the manner in which they should be applied to each one of them ought only to be determined after a complete examination of each one.

9.—NOTES ON A GREASE INTERCEPTOR.

By W. S. COOK.

Section I.

LITERATURE AND FINE ARTS.

PRESIDENT OF THE SECTION:

PROFESSOR E. E. MORRIS, M.A.

1.—AMONG THE WESTERN HIGHLANDS OF TASMANIA.

By W. C. PIGUENIT.

(Plates.)

THERE are no portions of Tasmania of which so little is known as the wild rugged region lying to the west and south west of the extreme limits of settlement in the Lake Country, nor are there any parts presenting such totally different features both in regard to form and colour. The great obstacle that has always presented itself to the examination of this interesting country has been its extreme difficulty of access. Lofty and rugged mountain ranges, deep ravines, great valleys, more or less precipitous, and covered for the greater part with dense forests and almost impenetrable scrubs, and rapid rivers liable to frequent and sudden floods, are among the chief difficulties which beset the explorer in his researches, requiring him to possess not only stoutness of heart and limb, but also those other necessary qualifications which go to make up what is technically known as a "good bushman."

No one with whom I have been acquainted possessed those qualities in a more eminent degree than my lamented friend the late Mr. James Reid Scott, who in past years con-contributed very largely to our knowledge of the physical geography of the country referred to, and to whom I owed many valued opportunities of placing within my portfolio sketches of the grand scenery which meets the eye on every side.

It is from these sketches that the illustrations I have now the honor of submitting to you for your inspection have been made, and in the selection of them I have kept in view, as far as possible, those most typical of its mountains, lakes, and valleys.

My first acquaintance with the south-western country was made in 1871, when accompanying Mr. Scott and a party of three men on an exploring excursion from Victoria to Port Davey *viâ* the Valley of the Huon. Our route was along an old track, which, passing close to that river, ended at the Craycroft. From thence we travelled in a north-westerly direction up the Arthur Plains, until we sighted Lakes Pedder and Edgar, the last named being one of the sources of the Huon. Thence south-westerly to Port Davey, passing between the Arthur and Franklin Ranges. For the first 43 or 44 miles of this route the scenery, with the exception of some charming glimpses one occasionally gets of a bend of the river, is for the most part not very striking; but if the landscape possesses but small interest so far, ample compensation is made the traveller by the magnificent view that suddenly bursts upon the eye when the summit of the last hill, overlooking the Arthur Plains, is reached. Mr. Scott, in a letter published in the Hobart *Mercury* shortly after our return, thus describes this grand scene:—"For my part I must confess that the beauty of the scenery, both in the grandeur of the mountain ranges and the brightness and harmony of colouring, far exceeded my expectations. The country is almost destitute of timber, excepting narrow belts along the sides of the streams, and the effect from an eminence is that the spectator is looking over a vast extent of well-grassed fertile valleys, bordered by precipitous rocky mountains rising abruptly from the green plains, and towering up into sharp peaks and fantastic outlines, such as I never saw elsewhere in Tasmania. The mountains being of quartzite or some silicious stone full of quartz veins, the delicate tints of the rocks (from pure white to silver grey, or pink in the light, and a deep atmospheric blue in the shadow) made a splendid contrast with the vivid warm green of the button-grass plain, and the darker green of the timber, kept always bright by the moisture of the climate. The brilliant colours were not due to the temporary effect of sunrise or sunset, but were continuous and ever varying in outline throughout the day. A closer acquaintance with the plains dispels the idea of their fertility, and we found that what appeared undulating, or nearly level country, was composed of many steep narrow ridges and broad spurs from the mountains, covered with large tussocks of button-grass—Gymnoschænus sphærocephalus (*Cyperaceæ*)—and a jointed rush-like plant—Leptocarpus tenax (*Restiaceæ*)—with many

LAKE PEDDER.

HELL'S GATES.

patches of ti-tree and various plants of the order of *Epacridæ.* The soil is wet and spongy, largely covered with moss at the roots of the herbage. The chimney-like holes of the land lobster abound all over the country, even on the tops of the hills. Towards Port Davey the ridges are more gravelly and the herbage shorter, the rocky hills assuming a whiter colour, as if snow-clad. We found slate protruding in many places, with a very good cleavage and a purple tinge, like roofing slates. The quartz is generally pure white, and there are many loose masses of it scattered about, looking like huge blocks of white marble. . . . The plains are well watered by numerous streams of various sizes, each bordered by a belt of thick scrub, chiefly of honeysuckle (*Banksia*) with a dense growth of bauera and cutting-grass, from 8 to 10 feet high, closely matted together, so that it is impossible to pass by pressing it aside. It must either be cut through or trampled under foot, so that much time is required to cross even the smallest creek. The bauera was in blossom, and we saw several of the 'prionotes' with their beautiful pendulous red flowers. . . . By the streams we found many plants of the Native Plum (*Cenarrhenes*) with ripe fruit, the Native Laurel (*Anopterus*), the *Agastachys*, and the *Hakæa epiglottis*, also the *Persoonia*, the Celery-topped Pine (*Phyllocladus*), and many others met with in the north. In the forests the prevailing fern, as in the north, is the *Lomaria procera*, and two very pretty species of the *Gleichenia*."

The water of these streams is of a dark brown colour, owing to the peaty nature of the country through which they flow. Singularly enough, they appear to contain but few fish, and those we caught were the small native trout,* none of which exceeded six inches in length. In this respect the southern rivers compare unfavourably with those of the northern side of the island, in which the blackfish often reach as much as four or five pounds in weight.

Resuming our journey, we reached Port Davey, where we camped for five days, experiencing during the whole of our stay very rough westerly weather. We nevertheless managed, with the aid of a boat obtained from a resident, to visit many parts of the port on its weather shore, and among others the grandest bit of scenery I believe to be found in the neighbourhood—that known as "Hell's Gates" on the Davey River.

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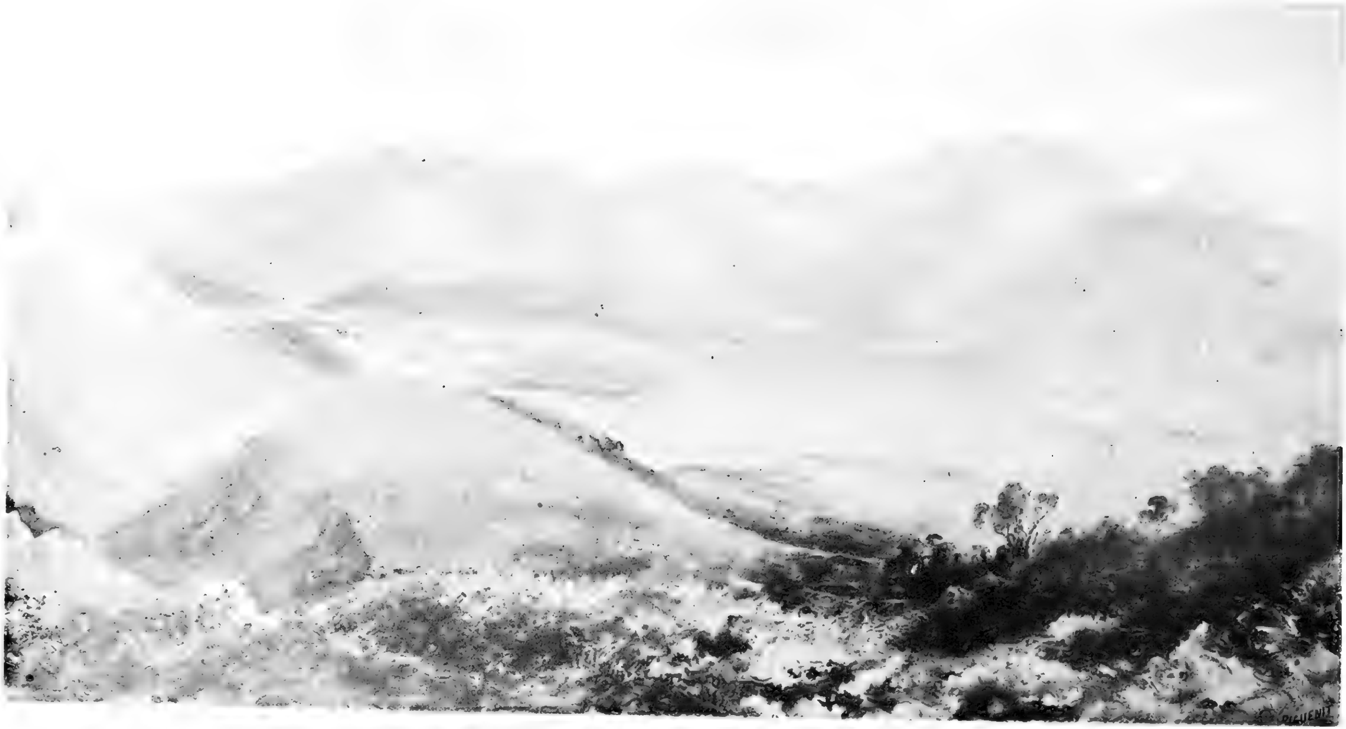
* Genus *Galaxias.*

The "Gates" are a tremendous chasm between two hills, whose perpendicular sides reach an altitude of from 250 to 300 feet. The river, at the time of our visit, was comparatively low and running at a moderate rate, but in flood time it rushes through the chasm with tremendous velocity. I had much difficulty in making the sketch from which the accompanying illustration has been taken, owing to the furious westerly wind that was blowing through the "Gates," accompanied with driving showers of sleet.

In a subsequent excursion made in 1874, on which occasion my esteemed friend Mr. R. M. Johnston was one of the party, we travelled over much of the same country, but instead of turning to the south-west after reaching the north-west end of the Arthur Range, we continued in a north-westerly direction until we reached the southern shore of Lake Pedder—a fine sheet of water surrounded by hills of a very picturesque character. The country bordering the southern shore is of a marshy nature, with numerous small tarns or lagoons dotted about, filled with the usual dark brown-coloured water peculiar to peaty soils. We camped for two days on this shore, experiencing during our stay the most tempestuous weather, compelling us, in setting up the tent, to seek the shelter of a clump of bushes to screen us as far as possible from the fury of the wind and rain.

After fording the stream connecting Lakes Pedder and Maria (the latter a small lake lying to the south-east of the former) we continued in a northerly direction with the object of striking the Gordon near the Great Bend and of following the Florentine down to its junction with the Derwent beyond Dunrobin bridge. What followed has, however, been so graphically described by Mr. Johnston in his valuable work on the "Geology of Tasmania" that I gladly avail myself of his kind permission to make the following extract:—"The perilous scrub already described may continuously extend for many miles along the narrow valleys, ravines, and precipitous slopes of the sub-Alps of these regions. The tops of the high razor-back ridges of the schistose rocks bordering the upper waters of the Huon and Serpentine are generally treeless, though extremely rugged, and in traversing long distances it is often preferable to keep upon the crest of these as far as possible, not merely to avoid the horizontal scrub of the steep slopes, and the green innocent looking bauera of the flats bordering the rivers, but also to have the advantage of frequently taking "trig" bearings of the one or two mountain



THE ARTHUR RANGE.

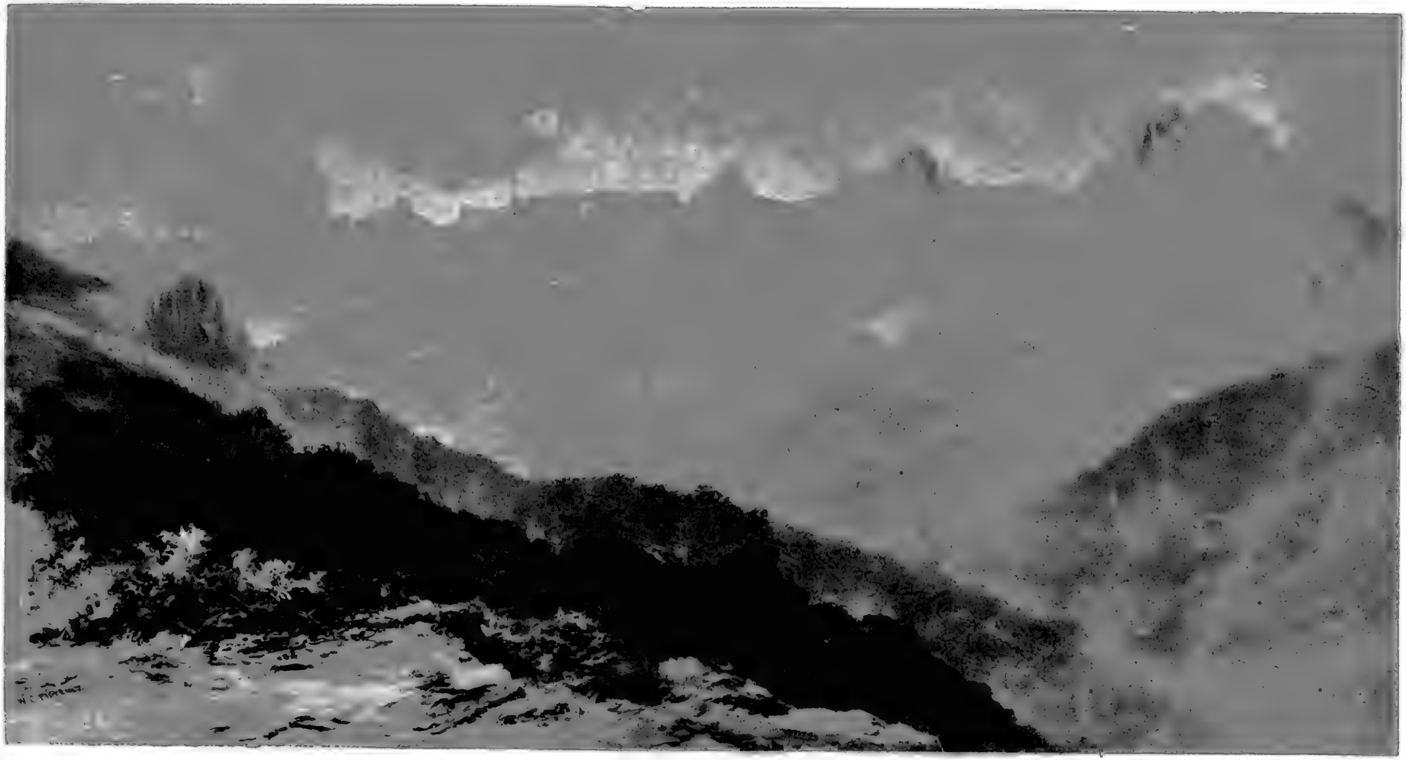
peaks which may be in sight, such as Mount Wedge, Mount Anne, Mount Picton, and the "trigs" on characteristic peaks of the Arthur, Franklin, and Wilmot Ranges. It also gives the traveller a great advantage in judging where to pierce a barrier thicket of vegetation at its narrowest point: indeed, no horizontal or other scrub should be encountered in this country before some local eminence has been ascended for the purpose of taking careful bearings of the day's course. It may be imagined, therefore, that progress in such a country is a slow and toilsome one, even to those capable of the greatest physical endurance. The difficulty of progress in the rugged horizontal scrub ravines and slopes between Lake Pedder, Mount Wedge, and The Thumbs, on the Gordon River, may be best illustrated by describing a day's toil of our party when endeavouring to cross the barrier ridges between the lake named and the open Denison Plains along the course of the River Wedge. After four days' fighting and tunnelling among the formidable scrub, we did not succeed in piercing in any one direction more than five miles from our old camp by Lake Pedder. In our final struggles to reach a white-crested peak—rising out of the sea of scrub —which we thought might bridge us over our difficult barrier northward, we were very much disappointed to find, on reaching its summit (only a mile distant from the last camping ground) that it was a solitary pinnacle, standing as a sentinel rock amid dense foliage on every side. There was no help for it but to retrace our steps in order to find a clear space to camp for the night. Only a little patch of green open ground, seemingly a mile below, was visible, and that too in the direction from whence we came. Reduced to one day's supply of food, we also reluctantly resolved to make a forced march back to supplies at the Picton, which would at least give us three days' hard travel. To be without food for at least two days was not a pleasant prospect, but the attempt must be made. Taking careful bearings of our course, we struggled down the steep, bare slopes, over chasms and precipices. Then commenced a most determined fight with the dense scrub. No description can convey an adequate conception of this short but hazardous struggle. At times we were in perfect darkness in the cavernous chambers of the moss-enshrouded branches; nor could we form any idea what height we were above the ground.

"The mode of progress is necessarily single file—the foremost doing all the hard work of cutting and bending aside

obstructing branches sufficiently wide to allow the body and knapsack to squeeze through; the rest follow closely, one after another, and render friendly assistance when necessary. The compass has to be consulted every few yards and on one or two occasions such was the darkness in our vegetable cavern that a match had to be struck to show the bearing of the needle.

"One incident alone in this forced retreat produced the utmost merriment to some of our number. In descending through a hole into a dim, gloomy chamber of the scrub, one member of the party immediately in front of me fell, and, striking some rotten mossy-covered branches of the floor, he sank down through the latter out of sight, and only by his cries could I find where he had disappeared. I could only see his boot, vainly jerking at the mossy sheet, which, after he had fallen through, had sprung back, concealing the deeper recess where he was lodged. In hurrying to his assistance I attempted to descend a sudden dip of some twelve feet, but before I could clear my knapsack from the branches which pressed upon me my foot slipped off a treacherous moss-covered trunk, and falling, I found myself suddenly suspended by my knapsack. Our united cries for help brought our companions upon the scene; but the ridiculous and helpless picture we both presented so excited their mirth that it was some minutes before they recovered calmness to extricate us from our curious and perilous situation. Minor incidents of this character were of frequent occurrence on this memorable descent; but although nearly exhausted with fatigue, steady determination at last enabled us to emerge upon the small open space of ground already referred to, where we camped for the night, having been engaged over twelve hours in piercing a distance little over a mile. At the close of the third day succeeding this we managed to reach our supplies at the Picton, having been two days without food. Although faint with exhaustion on this memorable journey, we resisted all temptations to throw away our knapsacks and collections, and only the abundance of water supply enabled us to successfully overcome the trials of the weary march, which reduced all of us to the appearance of skeletons."

In 1873 Mr. Scott fitted out a party for the purpose of exploring the country in the neighbourhood of Lake St. Clair, the Murchison and Eldon Valleys, &c., in which I took part. Mr. Scott had a boat built expressly for exploring the



THE MURCHISON VALLEY

MOUNT GELL.

lake, which was conveyed by bullock waggon from Hobart, and taken by way of Hamilton and Victoria Valley to within about a mile of its destination; from thence it was carried by us on our shoulders until the shore was reached, where a rough log boat-house was built by us for its protection. The tourist on his visit to the lake finds, on reaching its south shore, a noble sheet of water stretched before him, surrounded for the greater part by high and precipitous mountains, but it is only by the aid of a boat that he can see its grandest features, notably the views of Mount Olympus and Mount Ida, from the north-eastern shore. From this point of view the tourist, on looking across the lake to the south-west, sees the majestic outlines of Mount Olympus towering up before him in sombre grandeur, with the slopes at its base covered right down to the water's edge with a most luxuriant growth of myrtle (beech), fern, and other trees, among which may be seen the palm-like fronds of the *Richea pandanifolia.* Turning to the north-east, a huge rampart of precipitous mountains extends for some miles along this shore, amidst which stands the isolated bare peak of Mount Ida, with the talus at its base covered with a dense forest of Eucalypti. After breaking our way through the scrub and having a look at Lake Laura—a small lake lying at the foot of the mountains—we rowed up the larger lake to its north-west end, where we camped for the night, and next day followed the Narcissus River up its course for about a couple of miles, from whence we could see the rugged mass of mountains forming what is known as the Du Cane Range. Upon our return to the old camping place at the boat-house at Cynthia Bay, a start was made for the Eldon Range. Our course lay up the Vale of Cuvier, along the banks of the river of that name, and passing the southern shore of Lake Petrarch—a very beautiful sheet of water, to which the peaks of Mounts Byron and Cuvier form a noble background. Continuing on our journey we passed to the south of Coal Hill, keeping for some miles on the dividing range overlooking the Murchison. From this standpoint the sketch was made from which the illustration of the Murchison Valley was taken. A most extensive landscape here meets the view. The head of the valley lies at one's feet. On the right hand are the massive heads and peaks of the Du Cane Range; on the left the equally bold and massive spurs of the Eldon Range; while the valley stretches away into the dim distance, in which are to be faintly seen the

summits of Barn Bluff, the Cradle, and many other mountains.

It is difficult, without the aid of colour, to show to its full extent the marked change in the features of the mountains of the Lake Country, where the greenstone is the prevailing formation, when contrasted with those ranges lying further to the south-west, such as the Arthur, and the mountains in the neighbourhood of Lake Pedder, where the crystalline rocks with their striking outlines and varied delicate tints take the place of the dark massive-looking greenstone, represented by such mountains as Mounts Olympus and King William, and the Eldon and other ranges; but an examination and comparison of the illustrations of the Murchison Valley and Arthur Ranges will, I think, make this change sufficiently clear.

I should strongly recommend the tourist who does not object to a little mountain climbing, when in the neighbourhood of the King William Range, to ascend the first peak of that range. If care is taken in avoiding the thick scrub which clothes the base of the mountain, by selecting the ridge or spur on its eastern flank, the ascent is not difficult. Upon gaining the summit a magnificent view will reward him for his labour—for he stands in the midst of a vast panorama embracing almost the whole of the Western Highlands.

Looking over this grand landscape he will see an apparently endless succession of deep valleys and ravines, all densely wooded, and range after range of rugged mountains, all more or less precipitous. Many of these valleys, such as the Loddon for instance, are clothed with the densest growth of myrtle forest I have ever seen, imparting a beautifully soft velvety green to the landscape. Numerous lakes dot the surface of the country, while gleams of alternate sunshine and shadow flitting across it give to it a variety and charm of great beauty; at one time bringing some mountain peak into bold relief and imparting to it, if belonging to the crystalline order of rock formation, the appearance of being snow-clad, while others plunged in shadow are lost in the deep purplish blue of the distance; the whole making up a scene, wild it is true, but of such variety of outline and of such wealth of colour as to make the Western Highlands one of the most charming of the many beautiful landscapes to be found in Tasmania.

MOUNT OLYMPUS.

THE KING WILLIAM RANGE.

MOUNT KING WILLIAM.

2.—POPULAR ERRORS ABOUT ART AND ARTISTS.

By JULIAN R. ASHTON.

PERHAPS the most serious obstacle in the way of a thorough comprehension of the true value of the Fine Arts lies in the fact that, while all admit that study is necessary in the case of a doctor, an engineer, or a lawyer, there is a general feeling that with the painter, the poet, the musician, or the author it is almost superfluous. As a result we see that, while professors of what may be called the exact sciences are obliged to justify their claims to the positions they desire to hold, it is only now beginning to dawn upon the public mind that inability to make a living in any other way is not a sufficient certificate of proficiency either in painting or drawing. As a result, the training of the eye has, until lately, been entirely ignored in our educational systems, and the sense from which man derives perhaps the greatest and most lasting pleasure, left uncultivated. In order to prove this it is only necessary to ask a room full of well educated men or women to draw from memory, full size, the breakfast cup and saucer which they have been in the habit of using for the last twenty years, and it would be safe to assert that not one in a hundred would reproduce these common objects the right size or in the proper perspective. And if this inaccuracy can be proved with definite and common forms, how much more likely is it to be true as regards the intricacies of colour? Drawing is no more a gift born with a few than writing is; indeed, every boy who learns to write, not only could, but should be taught to draw. If the first object in teaching writing is to give the power of expression to thought, drawing not only is an added power of expression, but in many cases a much simpler and more direct one. The commonest form of box would require a sheet or two of written explanation to produce, in an ordinary carpenter's mind, an image sufficiently vivid for him to make it by. A dozen well-directed lines tells him what you want at a single glance.

While such an addition to our educational curriculum would result in much greater accuracy in our perception and registration of form and colour, there is no fear that it would produce a too abundant crop of painters. Great poets and authors have not been more plentiful since writing has been made compulsory; on the other hand, good literary work has, with the spread of education, become better appreciated, and has appealed to a larger audience. So, with a

juster understanding of form and colour, would a like effect be produced; and men in great numbers would admire the work of painters, not, as is commonly the case now, because the subject happens to please, but because of its artistic truth.

Art in its highest form never will be popular, all attempts to make it so notwithstanding. Art truly means the best expression of some phase of many-sided truth. The perception of this has generally been limited to a small minority, for, by the time the majority has adopted a certain set of views in art, as in everything else, its vitality has gone.

The most common error with regard to painting is the idea that it is possible to give valuable opinions about it without study or experience. Men who would shrink from sitting in judgment upon most questions with which they are practically unacquainted, will, in front of pictures, pour forth elaborate criticism and explanation which could astonish no one more than the artists who painted them. There have been pages upon pages of beautiful prose written by one of our great English critics in explanation of Turner's method which, from a painter's point of view, are practically worthless. No one can explain how a great man produces his picture. There it is. We feel that it is true; but the thing seems so spontaneous, so frank, and happy, that all we can say is—"How did the fellow think of that? why, it is perfect." As to explaining his method, as well explain the method of a skylark, who sings because he must. It is no use looking at or criticising painting from a literary point of view: the tendency is always to invest it with a literary aim. It is easy to conceive that in literature subject may be nearly all important; in painting it is nothing of the sort. This may be easily proved by remembering that many of the works which all painters agree in looking upon as masterpieces of art have no subject at all. Take, for instance, Velasquez' portraits, his infantas and courtiers. We are not at all interested in the human beings themselves, many of whom are not known, except through the fact that Velasquez painted them; yet to the painter they stand as unrivalled examples of his art. The subject which is everything to the public, is nothing to him; or, to put it in another way, it is the expression of the subject which is the important thing to the artist, while to the average man it is the thing expressed. The Impressionist (and all great painters have been Impressionists) asserts that when you look at a man the curtain behind him and the escritoire at his side are, though visible, not detailed to the

eye; but the public demands that, after painting the man with care and precision, the same care and precision shall be lavished upon the pattern of the curtain and the accessories of the escritoire. This is all very well in a photograph, but herein lies the difference between photography and art. The artist assimilates to himself that which suits his particular temperament; the rest is as if it did not exist.

Two painters go for a stroll together; the one sees beauty in some subject or scene which strikes no chord in the sensations of his comrade, who will go into ecstacy over a tone of colour to which his brother artist is insensible. I have driven miles with enthusiastic friends who promised to show me the finest scenery in the colonies, and have felt that I must fall a hundred per cent. in their estimation unless I went into raptures over views which to me were positively ugly. When will people begin to understand that the artist can only do well what he loves, and that what the public loves is of no consequence in the matter at all? But the greatest disadvantage under which we labour is the tendency of the general public to demand a subject as the *motif* of a picture. A sentimental or romantic story will always more than counterbalance weak or careless workmanship. The idea that a picture must have some lesson or moral to impart, is, it is true, slowly dying out, but it has still sufficient vitality to give it a power which must not be overlooked or underrated. Painting, like its sister art Music, should not depend at all upon teaching definite lessons, but upon striking responsive chords in the consciousness of the observer, producing thereby a thrill of sympathy upon which a false tone of colour would jar as keenly as a false note in one of Beethoven's sonatas. True, painting has the advantage over music of being able to reproduce definite scenes; but in choosing his subject, the artist who consciously works up a theme with the idea of teaching a moral lesson, rather than from an innate love of beauty for its own sake, will, I think, fail to produce a great picture. Great pictures have only happened as the result of the painter's natural love for his subject, assisted by the highest technical skill in execution. The artist whose nature is most touched by the beauty of flowers may do indifferently good landscape or figure work; but we may rest assured that if he ever rises to greatness, it will be in some expression of his natural love for flowers. The French painter Millet, whose deepest emotions were most stirred by study of the peasant life of France, for many years frittered away his talent in

order to paint nudes, a branch of art with which he had not the slightest sympathy, and in which he consequently failed. Only when turning from his misdirected efforts he allowed himself to be guided by his own special taste, did he achieve anything great.

With morals the art of painting has, I think, nothing to do. I should doubt indeed whether between any of the arts and what we call morality there is or ever has been the slightest connection. If there were, we might certainly expect to find that the most moral men were the best artists, and the most moral and order-loving people the greatest producers and patrons of art. History is emphatic in the assertion that this is not so. Speaking upon this point in that admirable "Ten o'clock Lecture" of his, Mr. Whistler says:—

"False again, the fabled link between the grandeur of Art and the glories and virtues of the State; for art feeds not upon nations, and peoples may be wiped from the face of the earth. But art is . . . . a whimsical goddess, and a capricious; her strong sense of joy tolerates no dulness, and, live we never so spotlessly, still may she turn her back upon us, as from time immemorial she has done upon the Swiss in their mountains.

"What more worthy people? Whose every Alpine gap yawns with tradition, and is stocked with noble story; yet, the perverse and scornful one will none of it, and the sons of patriots are left with the clock that turns the mill, and the sudden cuckoo, with difficulty restrained in its box!

"For this was Tell a hero! For this did Gessler die!"

In conclusion, it were well to say that the artist should not be daunted by the mistaken estimates which the public form of him or his work. It suffices that he speaks to a few, who will never become a majority. Even if the errors here pointed out should be admitted and swept away, he knows that their places will be filled by views of his aims perhaps even more erroneous. He must be content to live for art and for art's sake only; and, unmoved by the praise or blame of the amateur or the dilettante, accept for critics none but those whose claim to be heard rests on the safe basis of personal knowledge and experience.

3.—HERALDS OF AUSTRALIAN LITERATURE.

By T. A. BROWNE (Rolf Boldrewood).

COMMENCING with the best intentions, I fear that the task may prove over weighty for my powers of descriptive analysis. Australia! birthplace of my soul, more loved than even my native land, thee and thine I claim to know! But literature! Mighty word! Vast and ancient kingdom! How shall I essay to explore thy boundless realms, thy dim and awful recesses, thy sacred fanes? The simple expedient resorted to by Count Smorltork, of immortal memory, occurs to me. I look out Australia and Literature in the Encyclopædia Britannica, and combine the information. A difficulty, speaking more seriously, under which colonists have at all times laboured, is to insert the idea into the British mind that their kinsfolk, their own flesh and blood, even though transplanted to a new land, and living under somewhat altered conditions, are really not essentially different from their august European relations. "Cœlum non animum mutant, qui trans mare currunt" was said of old by a keen observer of human nature, but English critics will have it that we have necessarily "suffered a sea change into something rich and strange," or otherwise. They will believe anything but that their "kin beyond sea" have remained much the same Anglo-Saxons, Scots, and Hibernians that they were before they quitted Britain's shores. Nor will they believe that there can be diversity of "mind, body, or estate" among colonists. Still less, that there can be any unwholesome leaning towards the arts and sciences, suitable, even desirable, as such might be in old world communities. No! every well-instructed English person knows that the daily duty of all colonists, without respect of persons, is to chop down the vast forests in which they dwell, to contend with the bushrangers and Indians, by whom they are naturally surrounded, to wage ceaseless war with the vast forces of nature: the wild beasts, and yet wilder tribes of men, among which their secluded existence has been cast. To think of such people groping blindly after the poet's frenzy, the scholar's triumph, the philosopher's deep dream, was altogether too ludicrous. The prevailing sentiment was tersely, if not inelegantly, expressed in the English minister's historical answer to the Virginian planter complaining of some fancied injustice. "D——n your souls! Grow tobacco!" That summed up "the whole duty of man," of

colonial man. Where did, where could literature "come in," to use the dramatic idiom of the day.

Strange as it may appear to the untravelled Briton, literature has "come in," gum trees, bushrangers, droughts, and dingoes nothwithstanding, and from a very early period in the history of Australia. The brooding mind of the poet, the quick insight of the romancer, the analytical brain of the essayist, the keen memory of the historian, the wider perseverance of the searcher for scientific wealth, have not been unrepresented among the earth subduers whom the swarming hives of the old world cast forth on the void, pale wastes of the new. Slowly, gradually, but distinct in form and hue, they arose, the sons of art and song, amid the din of march and camp, though standing, perhaps, somewhat aloof from the multitude of loftier stature and more august mien. And who were they, in the dark, dreary days of a lonely outpost, so far across the restless main, when the fringe of arable land painfully won from the primeval forest yielded but a meagre subsistence to the deported labourers and their taskmasters? First, in a sense foremost in every department of effort to which he addressed a grand intellect and a vigorous organisation, looms the majestic form of William Charles Wentworth. An Australian of Australians he! Proud of his colonial birth, his colonial possessions, and that colonial greatness which his prophetic poet soul had foreshadowed, in this diminished son of soil we may, perhaps, without undue tendency to gasconade, discern that complete development of the individual which the conflicts of a colonial arena tend to produce. Poet and statesman, advocate and patriot, explorer and pastoralist, in every various occupation he was, in his own land, an acknowledged "anax andron." Born at Norfolk Island, a dependency of New South Wales, where his father, Mr. Darcy Wentworth, was Imperial surgeon, he was sent to England at the age of seven for his education. He returned to the colony in 1813. Scarcely arrived at manhood, his ardent soul found fitting vent in the historic exploration of the transmontane region, until then a *terra incognita*. With his heroic companions, Lieutenant Lawson and Mr. Gregory Blaxland, he dared the dangers of the unknown waste; with them returned, shoeless, starving, but successful. Threading the "horrible, hopeless, sultry dells" which lie between Katoomba and the boundless levels of the interior, they had discovered a track over barriers long regarded as impassable. Along this mountain highway passed, in annual procession, the long imprisoned

flocks and herds to a region where they could increase and multiply unchecked, where the numbers to-day exceed sixty millions of sheep, and more than ten millions of cattle and horses.

Having won his spurs, and fully approved his manhood in solving the riddle of the Desert Sphinx, Wentworth returned to England in 1816, and recommenced the literary course, which he never wholly abandoned. He matriculated at Cambridge, where he spent several years. In 1819 he published "a Statistical, Historical, and Political Description of the Colony of New South Wales." In 1824 a third edition was requested. We may well believe in the utility of this work in dispelling the ignorance which then prevailed in England, and (may we add?) still prevails to a certain extent with respect to matters Australian. While a student at Cambridge he competed for the Chancellor's prize poem on "Australia." He was second among 25 competitors, but the prize was awarded to Mackworth Praed, afterwards a member of the House of Commons. Praed's poem is an elegant specimen of versification, but patently inferior in poetic force and nobility of treatment to that of the Australian, whose descriptive passages were drawn from knowledge and experience, and whose ardent patriotism inspired him with the prevision of the Seer. The poem to which the Cambridge authorities awarded the prize might have been written by any student. It flows musically, like the brook murmuring along the meadows of an idyllic old world landscape. The other, faultless in cadence and rhythm, rolls majestically onward, bearing argosies of thought and classic treasure on its ocean billows, resonant with the rhythm of the southern main, heaving and seething unceasingly through the towering headlands of the great haven of the south. Rarely have the gods granted to the same man to be at once the daring explorer, and the poet-painter of the heroic past. Yet, this is one of Wentworth's exceptional achievements, apostrophising the Southern Alpine Chain, the "Blue Mountains" of the colonists:—

> "Hail mighty ridge, that from thy azure brow
> Survey'st these fertile plains that stretch below,
> And look'st with careless, unobservant eye
> As round thy waste the forked lightnings ply,
> And the loud thunders spring with hoarse rebound
> From peak to peak and fill the welkin round
> With deafening voice till, with their boisterous play
> Fatigued, in muttering peals they steal away ;

Parent of this deep stream, this awful flood
That at thy feet its tributary mud,
Like the famed Indian or Egyptian tide.
Doth pay, but direful scatters woe beside—
Vast Austral Giant of these rugged steeps,
Within whose secret cells rich glittering heaps
Thick-piled are doomed to sleep, till some one spy
The hidden key that opes the treasury :
How mute, how desolate, thy stunted woods,
How dread thy chasms where the eagle broods,
How dark thy caves, how lone thy torrents' roar
As down thy cliffs precipitous they pour,
Broke on our hearts when first with venturous tread
We dared to rouse thee from thy mountain bed,
Till, gained with toilsome step thy rocky heath,
We spied the cheering smoke ascend beneath,
And, as a meteor shoots across the night,
The boundless champaign burst upon our sight,
Till nearer seen, the beauteous landscape grew,
Opening like Canaan on rapt Israel's view."

In 1865 there died in Bathurst, in the 37th year of his age, one of the most brilliant men in the British dominions, a marvellous writer and speaker, a politician of great foresight. Truly an ill-fated son of genius, destined, like many of the sons of song, to perish in "loneliness, want, and pain." He, like his friend and countryman Dalley, was an omnivorous reader, having in his more prosperous days at his house at Woolloomooloo a choice and extensive library, containing rare editions and choice collections of the works of Latin and Greek classics, as well as of the best French and Italian authors, rich also in English poetry, polemics, history and the drama. Wide in his literary excursions, faultless in memory and quotation, brilliant in execution, popular, patriotic, accredited! Why should such a man fail? Why perish in his prime? Alas!

The name of Sir James Martin, late Chief Justice of New South Wales, is one which could not be passed over in any record of the literary personages of the day. This remarkable man was not born in Australia, but as he was brought to Sydney in his infancy, there received the whole of his education, and never quitted it afterwards, he may be regarded to all intents and purposes as an Australian. In common with Sir John Robertson, William Forster, Deniehy, and other men of mark, he received the more important part of his education at the Sydney Grammar School, then known as the Sydney College, and under the headmastership of Mr. T. W. Cape, the Arnold of New South Wales. We find

him there soon after 1834. He commenced his practice of the legal profession, of which he was destined to become so distinguished an ornament, in 1845. He contributed to the *Atlas* and *Empire* newspapers. In the year 1848 he began his political career, and was elected to represent Cook and Westmoreland. In 1856 he was appointed Attorney-General in the administration of Mr., afterwards Sir, Charles Cowper. He came into office as Premier in 1863, and in 1873 he retired from Parliament, and was appointed Chief Justice of the Supreme Court of New South Wales, which position he occupied until his death. His style in writing was not unlike that of his oratory—clear, concise, and effective. A sound classic, a good mathematician, a ready and powerful debater, there is little doubt, had not his absorption in politics denied him literary leisure, that his writings would have furnished for him an enduring monument. A master of our Anglo-Saxon tongue, whether written or spoken, in purity of diction, in force, in the wide grasp of great subjects, no man of his day excelled him. In his many-sided literary career he made various tentative efforts, comic, dramatic, prose, verse, fiction; but the absorbing labours of political life left no leisure for purely literary effort. But few, if any, of these fragments are, I fancy, preserved. One of them, a serial in imitation of the early numbers of "Pickwick," was an exceedingly clever production of its kind, more particularly as the work of a schoolboy.

I may be pardoned for having named primarily those writers, who, either by birth or rearing, were connected with New South Wales. But it will be seen that the children of the Mother Colony must necessarily, in order of seniority, take precedence of those of Tasmania, New Zealand, and Victoria. In Sydney my boyhood's days were passed, and the men whom I have mentioned were personally known to me, the majority, indeed, being schoolmates; the dates given will prove how short a time elapsed after the dreary, and in some respects discouraging, foundation of the colony before the irrepressible emanations from the sons of song commenced to irradiate the primeval forests. If I dwell upon this circumstance it is for the purpose of repeating the proposition that, given the ordinary environments of civilisation, any British community will exhibit the same personal differentiation of type, and evolve the same average of intellectual development. Of a later day than those last mentioned came Henry Clarence Kendall, a true-born Australian, the child

of the southern sea-woods, intensely patriotic in feeling, and permeated with every poetic sentiment which an ardent imagination evolved from that "waste land where no one comes or hath come since the making of the world." He displays in his poems, perhaps, more of the characteristic flavour of Outre Mer than any other writer. To him was given to interpret the whispers of the rills trickling through the fern-shaded glens of Orara, to behold the dread shape of the "Fever Sprite of Famine" who

> "Sits all the year time through
> Beyond the rainless Barwon, beyond the red Barcoo."

He it was who listened in the summer midnight under the burning stars of the South to the sad strange murmur of the forest oak, who mourned, weeping, in the deep despair of the poet's heart, a broken heart! "for that lost chord, that vanished dream, the song I cannot sing." Ere a few short years had passed, alas, "the lyre was broken, the minstrel gone!"

Taking a chronological view of early Australian writers, we may, for convenience sake, class them as the pre-auriferous section. They arose when Australia was strictly pastoral or agricultural, before the wondrous golden era, which was to change a colony into a nation, and to proclaim to the world a trans-Pacific treasure-house of boundless wealth. This division is of importance inasmuch as among the thronging thousands of adventurers who crossed the main, and dared the dangers of an unknown land, and a population presumably lawless, were four men, whose names are, in consequence of their literary work inspired of Australian conditions, known wherever the English language is spoken. I refer to Henry Kingsley, Marcus Clarke, Brunton Stephens, and Adam Lindsay Gordon. The golden lure attracted these strong spirits. They came to dig, they remained to write. An ironic fate refused them the treasure so bountifully bestowed upon the labourer, the idler, even the criminal, in the great gold lottery. Fortunately for us, for all posterity, hard necessity compelled them to transmute the undreamed of mental riches into permanent and negociable wealth.

> "And the individual withers
> And the world is more and more"

was literally, faithfully exemplified in the case of three out of four of the gifted quartette. Kingsley sleeps with his great kinsman in the old home of his race, which they both

had so lovingly painted; but above Clarke's and Gordon's graves bloom the wild flowers of that far south land, in which they, doubtless, confidently trusted to gather easily won wealth, and to quit with but scant regret. To each was it denied

> "One day to stand by the grey old grange
> While the children would gather all shy and strange
> As he entered the well-known door."

Still, as long as Australians forget not the language of their forefathers, as long as Milton and Shakespeare are among the echoes of a bygone glorious day, so long will the memory of these men be left green amid Australian wastes by wood and wold.

> "While the stock are slowly stringing
> And 'Clancy rides behind them singing,'"

be sure that "How we beat the Favourite," "The Lay of Britomarte," "The Ride for the Wreck," or "The Sick Stockrider" will be among the chants. Long years will pass before more critical students will cease to measure the force and beauty of certain verses of the "Rhyme of Joyous Guard" with the Arthurian ballads of England's greatest poet. And from generation to generation, so long as in tale or in tradition lives the sombre legend of the historic prison-house of Port Arthur, so long as the storm waves of the moaning main beat against the rock walls of the Isle of the Dead, Tasmania will shudder over the horrors of those mouldering dungeons, and pilgrims mourn over the hapless fate of Rufus Dawes as they read that terribly relentless lurid record, "His Natural Life."

Mr. John Lang (not related to the distinguished clergyman of that name) was one of the Sydney Grammar School pupils as far back as 1834. At an early age he began to exhibit exceptional ability. He was fortunate in being able to go "home" (long may it be ere this good old synonym for Britain be discarded by Australians), and to be entered at an English University. There he took his degree, was admitted to the bar, and returned to Sydney with the intention of entering the political arena under the ægis of Mr. Wentworth. After a short experience he decided to try his fortune at the Indian bar. An admirable linguist and admittedly brilliant advocate, he there acquired both fame and fortune, more than one of the latter, it is said, but unfortunately dispersed almost as soon as made. He was connected at the time with one of the leading newspapers (*The Englishman*). He amused

his leisure by writing novels, and a volume of sketches called "Wanderings in India." This last is now out of print; but I well remember several of the sketches. It resembles, in originality and picturesque effect, nothing so much, in my opinion, as those wonderful creations of the grandest artist of day in that school of design, the splendidly meteoric, Rudyard Kipling. His more completed productions, the "Ex-Wife," "York, you're wanted," "Will he marry her?" and others, were in their day highly successful, being admirably true to the state of society, which they purposed to describe. These all dealt with the men and manners of our eastern empire. But in his most popular novel, "The Forger's Wife," the scene is laid in Sydney in the old old days of transportation. It is a powerful, if occasionally painful book. It sells even now in all the colonies and in England by the thousand, and, as is not uncommon in the history of authors and their best productions, no relative of the late Mr. Lang has beneficial interests in the copyright.

The Hon. William Forster, ex-Agent General for New South Wales, though to all intents and purposes an Australian, was one of those Englishmen who in their infancy came to Australia. Like his great contemporary Wentworth, he was the son of an Irish army surgeon, belonging on the mother's side to a race of Kentish squires. He adopted the fashionable pastoral profession on attaining manhood, and had his share of the dangers of the wilderness, though such were his strong literary proclivities, combined with so combative and critical a bent, that no circumstances would have estopped him from intellectual conflict. His earlier literary efforts were directed against the ruling policy of the day, and a *jeu d'esprit* published in the *Atlas* newspaper, entitled "The Devil and the Governor," is still remembered. Another satire, "The Genie and the Ghost," followed. In a later day he wrote poems, which, though of high order, were hardly calculated to suit the popular taste. He deserted the domain of poetry in his later years for the more absorbing triumphs of party politics, where he obtained full recognition, alike by friend and foe, as

"In close fight a champion firm,
In camps a leader sage."

Of unchallenged integrity, of exact and pitiless logic, faultless in diction, elegant in versification, the name of William Forster, as author and critic, will always be associated with the literary movement of his day; while his steadfast adherence

to principle, his stubborn championship of abstract justice in every form, public or private, should serve as an exemplar and beacon-light to latter-day politicians.

William Bede Dalley was born in Sydney in 1831. He was chiefly, indeed almost entirely, educated at the Grammar School, then known as the Sydney College. I shall always consider Dalley, whom I had the honor of knowing intimately, one of the most surprising instances of the uprising of genius amid circumstances not particularly favourable, which this century has produced. Like Carlyle, his parents were of humble birth and station, neither having any pronounced tendency towards the pursuits in which their gifted son was destined so prominently to excel. Wonderful indeed must have been the natural capacity from which the sound, but not exceptional, method of education which he received, produced such astonishing results. As an orator, a poet, an essayist, a debater, a *succès de salon*, he was indeed almost unequalled; as a barrister he took high rank. Poetical and imaginative, he yet filled the high office of Attorney-General without failure of the good sense and practical knowledge in which the sons of genius are held to be deficient. The most charming of conversationalists, with a winning manner, refined, persuasive, delicately deferential, dignified by turns, there was no society, European or Australian, of which he was not fitted to be a distinguished member. His range of reading was widely comprehensive, his memory accurate and tenacious. He was an exceptionally good linguist, as well as an advanced classical scholar. As a minister he will always be remembered in association with the memorable Soudan expedition, through which, for the first time, Australia was enabled to repay in kind a portion of the lavish expenditure by which our infant nation had been fostered by their august motherland.

Daniel Henry Deniehy was another of the brilliant coruscations fated to arise amid the sombre atmosphere of colonial life. Born in Sydney in 1828, he was fortunate, after having commenced his studies under a master who was a remarkable linguist, in continuing them at the Sydney College, then, as afterwards, famous for the imparting of a sound classical education. Unlike the majority of classical students, he still pursued his French and Italian studies, reading under his first teacher, Mr. Johnson. At the age of fifteen he was taken by his parents to England, with the view of entering the University of Oxford. But, for certain

reasons, he was left in charge of a tutor. He found time and opportunity to visit his Irish relative. It was the eventful year of 1848, when, as was natural, he fell in with members of the Young Ireland Party, with whom he ever afterwards sympathised. On his return to Sydney he adopted the profession of a solicitor, and was articled to that modern Macænas, Mr. N. D. Stenhouse, the ever generous patron of men of letters. Of course he became a contributor to the newspapers of the day. His sketches at once attracted attention from their unusual vigour and originality. During the winter of 1853 he delivered a series of lectures on "Modern Literature" in the Sydney Mechanics' School of Arts. He was a brilliant speaker, and more than one of his speeches has been quoted as evidencing remarkable oratorical power combined with political insight. He was shortly afterwards returned to Parliament for Argyle, and in 1858 for West Macquarie. At the passing of the Electoral Reform Bill he withdrew from public life. In 1860 he became one of the proprietors of *The Southern Cross*, to which he contributed a number of essays and reviews on leading litterateurs. His essay on De Quincey has always been considered a masterpiece of appreciative examination. In 1863 he went to Melbourne, where, for nearly two years he conducted the *Victorian*, a political journal of decided policy. Like other promising ventures, the management was inferior to the literary talent. It failed, ruining the hopes and career of Deniehy, the lamp of whose life appeared to expire with the fated journal.

In Henry Kingsley's great novel, "Geoffrey Hamlyn," all genuine and conscientious critics must recognise the first, the finest Australian work of fiction worthy of the subject, of the great, the heroic subject of Australasian Colonisation. It was not his only triumph. In "Ravenshoe" we have a novel chiefly drawn from English life, only inferior to those of the fraternal artist who produced "Westward Ho" and "Hypathia."

Brunton Stephens is a poet, pure and simple. Few of his prose writings have come before the public. Measuring him with his contemporary singers, Gordon and Kendall, he must be acknowledged to be the most refined literary artist that Australia has ever inspired. His range is wide—from the exalted spirit soaring in the "Dark Companion" to the homely but irresistible comic sketches of "The Chinese Cook" and "To a Black Gin" and "Marsupial Bill." His forecast of "The Dominion of Australia" has an exquisite delicacy

of tone and treatment almost unequalled in poetic prophecy. For close connection with our national destiny, joined to a faultless harmony, the opening verses stand unrivalled. Brunton Stephens still lives to make good our boast of the possession of an Australian poet of the highest order, worthy of that niche in the Temple of Fame which, however exalted, we trust he may long delay to fill. May he enjoy the leisure to produce yet later works worthy of his fame, and long consecrate his muse to the sacred mysteries, viewless, save to the poet's eye, of the land of his adoption.

And now, I beg to humble myself in all sincerity, and ask pardon of the fairer portion of my hearers for having so long delayed to make mention of the literary work, in quality and class not below that of the preceding names referred to, performed by the women of Australia. Considering all things, it is not perhaps strange, but it is curiously coincident, that, addressing as I do a Tasmanian audience to-day, it should be made apparent that to that colony the world owes the larger part of the authoresses that have gained European reputation. For the most charming sketches of country life that ever came from pen since the days of Miss Milford we are indebted to Mrs. Meredith—*clarum et venerabile nomen*—as well as the most life-like artistic presentment of the plant life of her adopted land, interwoven with poems as delicately bright as the flowers they embalmed. The second place in Tasmanian literary work, must be given to the lady whose well-known *nom de plume* is "Tasma." Her works of fiction illustrate with fidelity the social life of Australia in a style of classical conception and finish hardly approached by any novelist of the day. It would be no extravagant laudation to refer to her as the Australian "George Elliot." And, indeed, whether it be due to the unequalled climate and the charming scenery of your beautiful island, combined with more Arcadian conditions of life than obtain in Australasia, it is incontestable that the palm of female literary eminence must be awarded to Tasmania. For, in addition to the two names which I have first on the list, we have Mrs. Humphrey Ward, the authoress of that remarkable book, "Robert Elsmere," which, whatever may be thought of its religious tendency, has been more widely read than any other novel of the day. The beauty of the style equals the absorbing interest of the story. Mrs. Ward was, I believe, born and chiefly educated in Tasmania, and therefore may be fairly claimed as a Tasmanian authoress. Another distinguished

dame, whose novels have received the hall-mark of Imperial approbation, Mrs. Campbell Praed, may be placed amid the Tasmanian galaxy. Speaking of this lady's works, I may give it as my opinion that no woman ever thoroughly mastered the vernacular, the true significance, as well as the dramatic aspects of the wilder pastoral life as she has done. She is far from the land of her childhood now, and her experiences have been considerably expanded, but she still continues to please her readers at home and abroad. Her reputation, like that of her sister authoress "Tasma," is European.

And now, to this "group of noble dames," all of Tasmanian birth or nurture, another must be added. (Really it seems to me that Section I., so far from being untimely slain by its cruel step-sister Science, ought to be retained, if only in the interests of the literary womanhood of Tasmania, so pre-eminent in the past, and destined, doubtless, for greater triumphs in the future). I must not further delay to mention the name of Mona Caird, the authoress of that truly remarkable article in a leading review, entitled "Is Marriage a Failure?" I wonder if it would come within the regulation of this august Society to put the question to the meeting—highly representative assembly as it is. Would the "ayes" or the "noes" have it? A momentous question, truly! It is needless to say, speaking as a Benedict of experience—of happy experience—that I am not in sympathy with the authoress's views, though I may admire the force and logic with which she presents her arguments. Her novel, the "Wing of Azrael," beginning in misery and ending in suicide, is scarcely a pleasing contribution to literature, though none can deny its talent as a composition. Reverting to the marriage question—how fascinating it is, has been, and will be! I may venture to interpolate the information (this being the I section) as my predecessor has discovered, that if he had not been fortunate enough to have been married, the present speaker would never have had a book to his name, and thus probably would not have received the honour of addressing you to-day.

Not, indeed, that other Australian colonies have failed to produce Unas and Britomarts worthily pre-eminent in the battle of literary life. But when we consider that the distinguished lady of whom we first spoke commenced her literary career full half a century since, it seems patent that the place of honor should be accorded to her. Coming to

later days, and another colony, I feel confident that a large proportion of my hearers are now reminded of the works of the lady whose name in literature is "Ada Cambridge." The right to stand in the front rank of Australian writers must always be readily granted to her. Her novels, written with clearness, accuracy of local colouring, and a method at once picturesque and conscientious, are no doubt familiar to most of you. Her poems, of which a small volume has been published, and which I regret not having with me to-day, have received the stamp of approval from high literary authorities among the reviewing magnates of Britain. In them will be found the deep thoughtfulness, occasionally of a sombre cast, the ardent aspirations and the daring unconventional suggestiveness, which marked the writings of the great Bronte sisters. Her minor pieces display an inborn love of nature, combined with unusual power of almost Pre-Raphaelite description.

The time would fail me were I to refer at greater length in this paper to ladies in other colonies who have added lustre to the diadem of Australian Literature. The late Mrs. Heron, of New South Wales, whose works were always admirable in taste and execution, was, from circumstances, chiefly ephemeral, and thus is in danger of being lost to the readers of a succeeding generation. Mrs. Foote, of Queensland, whose pathetic ballad "Where the Pelican builds her Nest" has the true flavour of Australia Deserta:

> "The horses were ready, the rails were down,
> But the riders lingered still;
> One had a word of farewell to say,
> The other his pipe to fill."

It will always stir the hearts of the dwellers in the Waste, and in days to come, when such things are of the storied past, many an Australian maid will think sadly of the brave brothers lying dead beside their horses in the mysterious drought-stricken solitudes of the "Never Never Country."

I must mention, too, the name of Mrs. Martin, of Adelaide, whose remarkable novel, "An Australian Girl," is well known in many an English home, and may serve to dispel the prejudices created by that ingeniously-venomous and spitefully-false production, "A Bride from the Bush."

In conclusion, I shall merely record my conviction that from the rising talent of Australia worthy contributors to every department of literature may be confidently predicted.

4.—THE PIONEERS OF AUSTRALIAN LITERATURE.

By ALEXANDER SUTHERLAND, M.A.

We who live in a prosperous and wholly civilised Australasia should not be too ready to forget that there had to be in every department of our national activity pioneers in a raw and only half civilised community,—pioneers who had to meet difficulties and hardships to which we are strangers. In literature, for instance, there is something pathetic in the recollection of those who spent their time and talents in writing, and their money in publishing, at a time when there was no public in Australia which could, on the one hand, appreciate the labor, or, on the other hand, reimburse the expense.

A pioneer poet who, like Charles Harpur, laboured in the production of choice and elevated verse, lofty in sentiment, chaste in diction, and appealing to a class of refined and imaginative readers such as are few in number in any part of the earth, but wholly wanting in a new country, should appeal strongly to the sympathies of those who belong to a somewhat more favoured generation. Is there not something touching in the thought of this fine old character, living a lonely life in the production of poetry which he well knew could bring him neither money nor fame in the community to which he belonged? He crippled his humble resources in the printing of verses which nobody bought, and nobody read; and when he died there were only a few people who knew that such a man had been among them, labouring to give them of the best that was in him.

The men who laid the foundations of an Australian literature, without hope of reward and with little expectation of reputation, are deserving of being remembered; and in this paper I propose to mention the most notable. Such a course is customary in the history of all literatures. There are always names that are held in honorable memory, not by reason of works of intrinsic literary merit, or not wholly for such reasons, but because they are the names of pioneers who made the way smoother for greater workers who came after. Such are, in English literature, Skelton, and Surrey, and Wyatt, and Tusser, and scores of others; such are, in French literature, Deschamps, and Chartier, and Villon; such are in German literature, Opitz, and Spee, and Gunther.

In Australian literature I shall name a few early writers whose works I should not specially recommend to anyone as

being of the first degree of merit, but merely as writers whom all who have an interest in Australia and her history ought to know to some extent.

And first among such writers I would place Wentworth, in many ways a most prominent figure in our early story. The first Australian-born who rose to any eminence, he figures in our annals as the patriot who by indefatigable efforts won for his native land the blessings of free British institutions to replace the autocracy of a penal settlement; as the framer of the constitution of New South Wales when she was permitted to assume legislative independence; and as the founder of the first Australian University, that of Sydney, where his statue now stands in a place of highest honour.

To all these claims upon our remembrance, he adds that of being our first man of letters. He was six and twenty when he left Sydney to proceed to Cambridge, and while there he wrote the first book of genuinely Australian origin. It had a twofold object; on the one hand to promote the emigration of free settlers to Australia, Wentworth rightly conceiving that only in that way could the status of his native land be raised. On the other hand he wished in this book to show how irresponsible was the rule of officials in Sydney, and how pernicious it was to preserve a severe line between the emancipated convicts and the free immigrants. In all his contentions he was eventually successful, and his book did good work for Australia; but looking at it strictly as a piece of literature it was not calculated to build up a reputation for its author. It has fine passages, and it is throughout marked by clear and vigorous use of the English language, but its subject-matter is too clearly of temporary interest to give it any chance to live as a work of art.

In later years Wentworth delivered many speeches of notable fire, and marked by no little eloquence in places, but they are upon topics now forgotten. He made one well known appearance as a poet. At Cambridge the subject in 1823 for the prize poem was to be "Australasia," and the young student who hailed from it as his native place could not keep silent upon such a theme. He asks,

> And shall I now by Cam's old classic stream,
> Forbear to sing, and thou proposed the theme?

When he remembers the happiness of his boyish days, spent in and around the Sydney Harbour,

> The tangled brake, the eternal forest's gloom,
> The wonted brook, where with some truant mate

I loved to plunge, or ply the treacherous bait;
The spacious harbour with its hundred coves,
And fairy islets, seats of savage loves.

he is roused on a far-off shore to the strong enthusiasm of vigorous verses.

One of Wentworth's claims to immortality consists in his having been the first to cross the Blue Mountains. After many unsuccessful attempts had been made during a period of twenty-five years to cross that formidable barrier, Wentworth with two young friends, Blaxland and Lawson, managed to find a road across, a feat which led immediately to the foundation of Bathurst and the opening up of the pastoral lands of the interior. Considering that it was close to that town that Hargraves discovered gold some thirty-five years later, and so opened up a fresh career for Australia, it is curious in this poem to come upon the following prophecy in describing the crossing of the Blue Mountains:—

Vast Austral giant of these rugged steeps,
Within whose secret cells rich glitt'ring heaps
Thick piled are doomed to sleep, till some one spy
The hidden key that opes thy mystery.
How mute, how desolate, thy stunted woods!
How dread thy chasms, where many an eagle broods!
How dark thy caves, how lone thy torrent's roar
As down thy cliffs precipitously thy pour;
Broke on our hearts when first with venturous tread,
We dared to rouse thee from thy mountain bed.
Till, gained with toilsome step thy rocky heath,
We spied the cheering smokes ascend beneath.

Throughout the whole poem there is a feeling that the writer is uttering the sentiments that come warm from the heart, and this of itself makes the reader feel a living interest in it. His hopes and aspirations for his native land constantly occur in uncompromising fashion. For instance, he was one of the very earliest advocates of the cessation of transportation to Australia, and his feelings are thus expressed:—

Land of my hope, soon may this early blot,
Amid thy growing honours be forgot.
Soon may a freeman's soul, a freeman's blade,
Nerve every arm, and gleam through every glade.
No more the outcast convict's clanking chains,
Deform thy wilds and stigmatise thy plains.

He lived to take a prominent part in carrying out the aspirations thus early formed.

It is pleasing also to see in this poem the adumbration of the Sydney University that was to be,—

And thou, fair Science, pure ethereal light,
Beam on her hills and chase her mental night.
Direct her sons to seek the perfect way
Where Bacon traced and Newton led the way;
But mid the future treasures of their lore,
Still foremost rank the Greek and Latin ore.

Towards the end of the poem he prays that Poesy may find a dwelling-place on these southern shores, and concludes with lines that are now well known—

And Australasia float with flag unfurled
A new Britannia in another world.

It is a curious comment on the value of such literary competitions that the prize was won by Praed, in a poem which must move the ordinary reader to laughter by the absurdity of its description. The Australian aboriginal woman is, according to Praed, clad in glittering trinkets and in gorgeous vest, and in general the Australian black is a being compounded of many vague imaginary qualities which form the ordinary stock savage of romance. Nor does Praed's poem gain anything on a comparison of poetic styles, the smoothness of its heroics being much more tiresome than the less polished but more virile rhythm of Wentworth.

The second of the pioneers of our literature is that stout old partisan, Dr. Lang. Though not of Australian birth he came to our shores while still young, and his life's work was done for us, and among us. He has nothing that we can greatly admire in regard to literary style. His English is slipshod and disfigured by a feeble disgressiveness, which deprives it of all dignity; and the egoism which is for ever coming up to the surface is not that pleasing form of self-revelation which at every turn interests the reader by showing the inward workings of a strong mind. It rather irritates than amuses; and when, to this egoistic vein, there is added a violent polemic tone which is both intolerant and aggressive, it scarcely remains to be said that Dr. Lang's work is not high-class literature.

Yet it has influenced the fortunes of Australia to no slight extent; for Dr. Lang was one of those who, like Wentworth, saw that the future greatness of this country would depend on the influx of free emigrants; and his earliest writings were devoted to the promotion of that object with most substantial effect. Subsequently he threw himself into the movement for dividing Australia up into portions suitable for convenient management. He saw that the legislation which

would suit the temperate reigions of Port Phillip would never be in all respects wholesome for the semi-tropical regions of Queensland; he ardently espoused the cause of those who wished to see Port Phillip separated from New South Wales, and was, to a very large extent, instrumental in bringing about the result. Again, he took up the cause of Moreton Bay, and gave it substantial assistance in securing its separation, under the name of Queensland.

Of the twelve books which Dr. Lang published, there are three which are occupied with these topics, while a fourth deals with the question of what he calls "Freedom and Independence for Australia." His restless brain was ever busy with some new idea, and he was the first to promulgate the doctrine that these colonies must at an early date cast themselves adrift from the British Empire. He used very largely what I believe to be the false analogy of the colonies of North America—false because the treatment which the Australian settlements have uniformly received has been so different from that which drove the Americans into righteous rebellion. This book is pedantic and arrogant, and it has few excellences to set against the general unpleasantness of its tone.

A fifth book is devoted to Emigration, and a sixth to "Transportation and Colonisation," both useful books in their way, but not marked by any great literary merit. A book of Dr. Lang's, on New Zealand, published in 1839, had some little influence upon the fortunes of the colony that was founded there in the following year. A work of earlier date, on the "Origin and Migrations of the Polynesian Races," broached some theories which held their place for a while, but are now, I believe, mostly forgotten.

But the book by which he will be best known is his History of New South Wales, a work in two volumes, which has run through many editions. It is a book of that class in which one finds much to interest him, but little to admire. It is verbose, it is egoistic, it is digressive, and it has none of that sense of the proportionate value of events which is so essential a feature in a good historian. But it justifies itself by being the most readable account of the first half century of Australian history; for neither Braim's pragmatic volumes, nor the collection of ill-digested facts made by Flannagan, can be called in any way readable, though they have a value of their own as quarrying ground for subsequent writers. It would be impossible to quote from Lang's history any

passages that would give the least hint of grandeur of thought or elegance of style; the whole is commonplace, and yet it is of that gossipy kind of commonplace which everybody is inclined to read, without very well knowing why.

Only a year or two after his arrival in the colony Dr. Lang printed in Sydney a small volume of poems, mostly composed on the voyage out. This slender little book of about 100 pages, and called "Aurora Australis," is notable in our history as the first piece of genuine literature, however humble, that had been actually printed on these shores. There had been printing for many years before, but never a book that had any pretensions to literary taste. It is true that nine years previously, Mr. Barron Field, one of the two Judges of the Supreme Court, had published a volume of verse which he called "Botany Bay Flowers," but they are too ridiculous to be regarded in a serious light. Aurora Australis, the first volume of verses that Dr. Lang published, has pages here and there which may reasonably enough be ranked as poetry.

But there is distinctly better work in a volume which he published in 1873, in Melbourne, under the title of "Poems, Sacred and Secular." The verses it contains were written in the first instance for Sydney journals, between 1820 and 1830. The poem in *ottava rima*, entitled "A Voyage to New South Wales," contains fine lines in places. One pleasing passage, descriptive of the scenery, the author saw as his vessel neared Hobart, has been inserted by Longfellow in the collection he calls "Poems of Places." The following are three stanzas from his description of D'Entrecasteaux Channel as it was in 1820:—

'Tis a most beauteous Strait. The Great South Sea's
  Proud waves keep holiday along its shore,
And as the vessel glides before the breeze,
  Broad bays and isles appear, and steep cliffs hoar,
With groves on either hand of ancient trees
  Planted by Nature in the days of yore:
Van Diemen's on the left and Bruni's Isle
Forming the starbord shore for many a mile.

But all is still as death. Nor voice of man
  Is heard, nor forest warbler's tuneful song.
It seems as if this beauteous world began
  To be but yesterday, and the earth still young
And unpossessed. For though the tall black swan
  Sits on her nest and stately sails along,
And the green wild doves their fleet pinions ply,
And the grey eagle tempts the azure sky,

Yet all is still as death. Wild solitude
Reigns undisturbed along that voiceless shore;
And every tree seems standing as it stood
Six thousand years ago. The loud wave's roar
Were music in these wilds. The wise and good
That wont of old, as hermits to adore
The God of Nature in the desert drear,
Might sure have found a fit sojourning here.

Dr. Lang was not a poet; but he did once or twice in his life write a few pleasant verses, and he might have possibly written many more if he had not devoted the leisure which the occupation of a busy clergyman allowed him to the task of fighting a hundred people all at once on a score of different topics.

But the man whom we are to venerate as the first apostle of true poetry on these shores is Charles Harpur, he of whom Kendall sings:

So we that knew this singer dead,
Whose hands attuned the harp Australian,
May set the face and bow the head,
And mourn his fate and fortunes alien.

For when the fiery power of youth
Had passed away and left him nameless,
Serene as light and strong as truth,
He live his life, untired and blameless.

And far and wide this man of men,
Of wintry hair and wasted feature
Had fellowship with gorge and glen,
And learnt the secret runes of nature.

From his earliest years Charles Harpur was a son of the forest, and knew the Australian bush as few others have had opportunity of knowing it. His father was a schoolmaster in the days of the early settlement at Sydney; he was engaged in the service of the Government at Windsor, on the Hawkesbury, and it was there that the youthful poet passed his boyhood, wandering far and free through all the forests that lie between the sea and the Blue Mountains: penetrating far into the romantic recesses where the tributaries of the Hawkesbury gather their fern-enfolded waters: climbing the slopes of the mountains themselves in those pristine days when all was remote and solitary and mysterious. As a young man he had experiences of cedar-cutting, and of other occupations which made him live for weeks and months far in the wilds, with no companion with whom a mind like his could hold converse, save a treasured volume of Shakespere or of Coleridge, of Wordsworth or of Shelley.

Can we imagine him, away back in these early days of the colony, spending his leisure after a day of labour in musing beside some mossy stream, while sonnets fashioned themselves after the manner of Shakspere or of Wordsworth? And yet not often did he write of the sights around him. His mind was of an almost morbidly imaginative complexion; he lived in worlds of enchantments and transmigrations; in dim Oriental luxuriance, and the glamour of fairy realms. His poem the "Tower of the Dream" is as weird as anything Coleridge ever wrote, and almost as musical; nor is it a mere imitation of any of Coleridge's poems, but rather a finished work such as Coleridge might have written on a topic different from anything he has really handled. His "Witch of Hebron" is also a fine poem, a very fine poem, but what chance of recognition has it when it is understood that it belongs to a class of poetry as essentially imaginative, and as utterly opposed to all that is realistic as are any of Shelley's works. And if the "Witch of Atlas" of Shelley is understood and appreciated by only a very few hundreds in the whole range of the Anglo-Saxon race, is it probable or is it even possible that Harpur's "Witch of Hebron" could find twenty people in all Australia that are capable of appreciating it?

Not that Harpur's "Witch of Hebron" is in any way an imitation from Shelley's "Witch of Atlas." Their titles are similar, and they are both wildly imaginative pieces; but there the resemblance ends. Shelley's rhapsody, glorious though it is, leaves only the impression of a wild profusion of poetic imagery. Harpur's poem is a legend of the East; it tells a consecutive story, though its events carry the reader into the most astonishing realms of wonderland.

Harpur's sonnets are extremely graceful. He published a small volume of them in 1840, at a time when, so far as recognition in Sydney was possible, he might as well have printed them in Sanskrit. I doubt if he ever had half a dozen readers. And yet many of them would pass without challenge if we met them in the pages of some of our greatest masters.

> She loves me! From her own bliss-breathing lips
>   The live confession came, like rich perfume
>   From crimson petals bursting into bloom!
> And still my heart at the remembrance skips
> Like a young lion; and my tongue, too, trips
>   As drunk with joy! While every object seen
>   In life's diurnal round wears in its mien

A clear assurance that no doubts eclipse.
And if the common things of nature now
  Are like old faces flushed with new delight,
Much more the consciousness of that rich vow
  Deepens the beauteous, and refines the bright,
  While throned I seem on love's divinest height,
Mid all the glories glowing round its brow.

Charles Harpur's best effort in the direction of local poetry is to be found in his "Creek of the Four Graves," which is on the whole the finest piece of blank verse written in Australia. His ballad of "Ned Connor" is a strong and surprising piece of work; once read it is not soon forgotten.

Harpur lived a truly pioneer life. He apologizes for his verses in lines which thus begin:—

And wonder ye not if his speech be uncouth,
Nor look ye much for his rhymes to be smooth,
Nor that the flight should be lofty and free
Of one with so little of learning as he.
For all of his aptest years were past
In primal solitudes, wild and vast.

In the last of his sonnets he tell us that he has no care for gold, nor any strong desire for honors. He feels that he does not write in any hope of fame.

But in retirement, where the muses dwell,
That his life's legacy might be—a well
Pierian, in a wide and thirsty land.

Is he not therefore one worthy of our warm regard as a pioneer of higher aspirations in Australia?

One last name and I have finished. It is that of James Lionel Michael, a contemporary of Harpur's, and a genuine Australian, though born and educated in England. He was a solicitor practising in Grafton, on the Clarence River. A man of quiet tastes, after losing his wife he dropped into semi-recluse habits; devoted himself wholly to his library, and consoled his leisure with the writing of poetry, much of it very poor, but with here and there a piece of almost inspiration to redeem the whole from barrenness. As he says himself,

'Tis bad enough
And yet, among its jingling rhymes,
  There is a little sterling stuff,
That reads like poetry sometimes.

His first venture was a volume called "Songs without Music," published in Sydney in 1852; it consists of a collection of lyrics, sweet and musical, somewhat vapid as a rule, but now and again stirred with something that touches the reader.

He sings very pleasantly of domestic affections; his allusions to the wife he had lost are pathetic; his humorous outbursts of democratic feeling are sometimes clever, and a few of the pieces have an autobiographic ring which gives them an interest of their own.

Michael's next venture was "John Cumberland," which next to "Ranolf and Amohia" is the longest poem of Australian origin, and is, I think, absolutely the longest poem ever printed in Australia. It purports to be a poet's autobiography. I would recommend it to those who have time to spare, for though by no means of prime value, it is interesting in its way. Silly in some respects, weak as a rule, it is nevertheless marked by poetical passages, and in its transparent simplicity one finds a certain reflected interest in observing the character of the author through the pages of his book.

Michael published other volumes, and drowned himself in the Clarence; the latter event eliciting considerable public attention, which the former had entirely failed in doing.

Michael and Harpur were the poetical godfathers of Kendall, who spent some years of his youth and early manhood as clerk in Michael's office in Grafton. He lived in the house with his employer, and had the use of his library. Michael also encouraged his youthful efforts at versification, and sent some of his earliest verses to Sydney newspapers. But Harpur was much the better poet of the two, and it was he whom Kendall regarded as having truly tuned the "harp Australian." Kendall always regarded himself as the pupil of Harpur.

There are other names that occur to one in speaking of the pioneers of Australian literature,—Henry Halloran, Henry Parkes, and so on,—but these do not recall any recollections of lives that were spent in the service of literature, and more or less sacrificed to the production of books which were sure of an ungracious reception in countries too young for the appreciation of such efforts. The names of those who were in their way martyrs in a good cause have been already recorded in this paper.

5.—SECONDARY EDUCATION IN AUSTRALIA.

By PERCY A. ROBIN, M.A.

EVER since the publication of Bacon's Advancement of Learning, in 1605, the scientific basis of education has been more or less definitely recognised. Glimpses of this truth had indeed been gained nearly 2000 years before by the versatile genius of Aristotle, who wrote that in education "we must conform to the results of psychological analysis," and that "every art and system of training aims at supplying the deficiencies of one's nature." To Bacon, however, is due the honour of having referred to pedagogics as a branch of psychology. Though many systems based on rational principles have been constructed since the intellectual revolution heralded by Bacon, yet recognition as a science has only recently been accorded to education. The systems of Comenius, Milton, Locke, Rousseau, Pestalozzi, Kant were, as it were, feeling after a scientific basis, but it was Herbart, the Königsberg Professor of Philosophy and Pedagogy, who, just half a century ago, established its close dependence upon the sciences of psychology and ethics. Since then, English as well as German philosophers and teachers have been building upon this foundation. Among English writers on the scientific aspects of pedagogy it will suffice to mention Mr. Herbert Spencer, Professor Bain, and Mr. James Sully. Great activity also is now being shown by the general body of English educationists. The Teachers' Guild of Great Britain and Ireland, the Royal College of Preceptors, the National Union of Elementary Teachers, the Association of Assistant Masters in Secondary Schools, the Annual Headmasters' Conference,—all bespeak an active interest in the improvement of the theory and practice of teaching. Yet the wave of progress seems hardly to have reached Australian shores. Regarding their occupation as an art, or at most as a rational system, Australian schoolmasters seem not to rise to the higher conception of an educational science. If it were so, the laws of mental phenomena would be the recognised basis of every scheme of teaching. It would at least be acknowledged that physiology, psychology, and ethics are the ultimate standards for testing the school course and for regulating all special methods of tuition. Yet in how many schools is the time-table intentionally adjusted so as to accord with the laws of mind? In how many schools are subjects consistently taught in accordance with scientific ideas? To go into details

would prolong this paper to undue limits, but it may be remarked, in passing, that in many schools language-teaching still proceeds on Sturm's unscientific method of "gerund-grinding" before translation; that inductive teaching has not yet supplanted the pernicious authoritative method; and that, to refer now to the earliest stages of education, books are made use of before the senses have been adequately trained, and thus words instead of things become the staple of a child's knowledge.

The importance of developing the science of education must be impressed not only on schoolmasters, but on the whole community. Every individual is more or less affected by its progress or retardation, although he generally becomes aware of this only when the training in his own case has come to an end. But everyone who is in any way responsible for the bringing up of children—and this means one or more in almost every household—is profoundly concerned with the increase of educational efficiency and the advance of educational science.

The chief modern contribution to the science has come from the connection of mental with physiological phenomena. Though (as Professor Bain points out) the training of the body is not *per se* a part of education except in the earliest stages, yet the study of physiology (including hygiene) safeguards the health of the physical constitution; and, as Mr. Herbert Spencer remarks, "the first requisite to success in life is to be a good animal." But, in spite of our past advances, there is still a wide and promising field for exploration. Some of the most important problems still remain to be solved, and what has been done in the past is but the preparation for the greater work of the future. Why, then, do not Australian educationists make combined efforts to map out the field of their labours with systematic accuracy? We may not be able to establish those experimental schools which Kant advocated for the purpose of trying new methods of teaching, but other means are within our reach. It is not necessary to enter upon strange paths for the purposes of investigation, but to utilise to the full all the means of advance which we possess.

1. Let us glance, first of all, at the present stage of secondary education in Australia. In some respects our schools are scientifically abreast, if not ahead, of those of England. Their curriculum is on the whole more modern, less pedantic, and more rational than that of the great

English public schools. To be sure there are many secondary schools scattered throughout the mother country which have as liberal a course of study as that with which we are here familiar, but the great public schools, such as Eton, Winchester and Westminster, are in a transition state, the modern subjects pressing for recognition in a curriculum which until recently has been almost exclusively classical. The English Public School system—based on the plan of a Strasburg schoolmaster of the Renaissance, and variously modified in turn by the influence of the Jesuit schools and (at least as regards physical education) by the thinkers whom Mr. Oscar Browning calls the "Naturalists," *e.g.* Locke and Rousseau—remained until half a century ago a stereotyped pedantry. But the mighty influence of Dr. Arnold from within, and the forces of a widening civilisation from without, have brought about a movement among the dry bones. Gradually a more natural and scientific system is being adopted, and recognition given to a wider course of educational subjects. The secondary schools of Australia—meaning by that term all which prepare pupils for the University—include in their curriculum Latin and Greek (with prose, but not verse composition), mathematics (including arithmetic, algebra, geometry, trigonometry, mechanics, and conics), one branch of elementary science (usually either chemistry or physics), English language and literature, English and ancient history, geography, and a modern language (French or German). Of other subjects, drawing is taught almost everywhere, but as an optional subject; book-keeping is similarly recognised. Most large schools have a double classification, for general subjects and for mathematics respectively; and a bifurcation in the Upper School into classical and modern sides, the modern taking no ancient languages, and devoting more time to mathematical and English subjects. Few of the larger institutions are without a gymnasium, a chemical laboratory, and spacious grounds for field sports. Cadet corps are now the rule, with their adjuncts in the form of rifle and carbine clubs. The chief feature that would attract notice from an English observer is the invariable combination of day and boarding schools. No doubt Mr. Oscar Browning would recognise these as a fulfilment of his prophecies, or at least as approximating to the type he favours. No large schools exist solely for boarders: in the majority about 75 per cent. are day scholars, who of course retain the advantages of home influence. The hours of work under such circum-

stances must of necessity be almost consecutive; hence the usual arrangement is to teach for three hours in the morning, and two to two and a half in the afternoon, the home work for the evening being supposed to occupy two or two and a half hours. In many respects this type is the ideal to which English educationists are aspiring, but we may not conclude from this that education in Australia is more advanced than in England. It is possible that we have the "form" without the "power" of education; that it is with us not a living organism, but a mere machine. Indeed we may rightly check our growing complacency by the question, What have we that we have not received? How far have our ideals been heightened or our methods improved by our own reflection or practical sagacity? We have but entered into the labours of our predecessors: what are we doing to develop our inheritance?

2. The defects of the present system of secondary education require ampler treatment.

(1.) Secondary education is chiefly empirical, few teachers having any scientific knowledge of the theory of education. It is on this point that professional teachers in England are now focussing their attention, and in the higher value attached to the training of secondary teachers lies the great hope of future advance. A useful parallel is supplied by the profession of medicine. The science of healing the body is not of higher importance than that of training the mind and character, yet the entrance to the one profession is rightly guarded, while the other is a veritable cave of Adullum, to which "everyone that is in distress, everyone that is in debt, and everyone that is discontented" gather themselves. Since, therefore, it has been found practicable to enforce a preliminary scientific and technical training upon all intending physicians, surely it is at least as feasible to insist, in the case of a teacher, upon a preparatory course of study and practical work. As a matter of fact, how do secondary teachers now fit themselves for their work? An increasing proportion enter on this with a university degree: so far so good. But whether they are graduates or not, their professional training begins with the *practice* of their profession! They have to begin experimenting in the practical subjects of discipline and form-management. This of course must be gone through in any case, just as no one ever learns to swim by theory before plunging into the water. But the man who starts with a knowledge of the laws of mental phenomena has an immense

advantage over one who sees in every schoolboy offence nothing but malicious personal aggressiveness, and in every schoolboy difficulty a wilful refusal to acquire knowledge. It is not so much in discipline as in the matter of teaching that the present system is so defective. For in the art of managing boys and girls, while theory counts for much, it is patient and intelligent practice that is indispensable. But in imparting knowledge and in training faculty, the want of previous knowledge of method is of far more disastrous consequence. It is a mere commonplace among schoolmasters that the first year—some would say two years—is almost wasted in learning how to teach. Each assistant is set to find out methods of instruction for himself, while the head occasionally examines the work, making many cutting but few suggestive comments. The principle of *solvitur ambulando* finds here its highest and most melancholy application. The class-room is like a chemical laboratory in which a tyro experiments with reagents whose properties he does not know. The explosions, the extraordinary precipitates, the destruction of apparatus and of clothes, all find parallels in the work of a raw schoolmaster. At the end of a year when his work comes under review, he knows the materials at his command and has acquired methods for future use, but he has little or no successful teaching to look back upon. He recognises how much he might have achieved if the knowledge he has thus painfully acquired had been his at first. If there is this need of a preliminary study of method, a knowledge of educational theory is equally important. The first few months of most new teachers—and years in the case of some—are inefficient not only for want of good methods, but also through ignorance of the laws of mind and body. Intelligent and enthusiastic men and women usually acquire their own mental science through close observation of pupils under their charge, but all is empirical and lacks scientific value. Secondary teaching will never be at its zenith until a knowledge of the science and art of education is the *sine quâ non* of admission into the profession.

(2.) The consequence of this blemish is that of all professions, teaching is the "tainted wether of the flock." It is not in itself a learned profession, for even the modern attainments of Goldsmith's Village Schoolmaster suffice, at the present day, to open its portals. The increased consideration and respect which have been shown to it of recent years are largely due to the number of university men who have

thrown in their lot with educationists. But of these it would seem that most have conferred a boon on the profession by countenancing it, and have indeed adopted the occupation as a *pis aller*. Teaching, as teaching, is not put on a par with the learned professions, although with one obvious exception it is the noblest and most exacting of all. Yet there is no reason to complain of this, for teachers as a body have not the qualifications of a learned profession: why then should they have its honours? As long as there is indiscriminate admission into their ranks, so long will their body be discredited in the eyes of the public. In the case of private schoolmasters, there is absolutely no guarantee of any professional acquirements; in the large public and denominational schools the appointment of assistants by the headmaster or mistress supplies an assurance of their general fitness for the work required. But who ever heard of a headmaster requiring of his assistants a previous study of educational theory or of psychology? Though an applicant brings no testimonials to his teaching power, he is planted down in a class-room to find and conquer his own difficulties, which might often be anticipated and minimised by a brief period of preparatory training. The fact, therefore, that any individual belongs to the teaching profession is not *per se* any evidence of high intellectual or professional attainments. If he be a university man he has a certain social status on that account, but a teacher, *quâ* teacher, has no standing in society whatever. In the legal and medical professions, a practitioner is presumed to be qualified for any social position until he proves unworthy of it. But in the case of a teacher, the presumption seems to be the other way, and we find university men almost apologising for being schoolmasters, and entrenching themselves behind their academic distinctions against the slights attendant upon their profession.

(3.) There is little or no encouragement to assistant teachers to perfect their professional knowledge and skill. The highest posts are confessedly beyond their reach. In discussing this topic, one thing may be laid down as undeniable —that the headmaster or mistress of a secondary school should be a university graduate. But here the question arises,—Given two graduates engaged in teaching, should the higher degree of one outweigh on the part of the other a greater theoretical and practical mastery of the science and art of education? The practice has hitherto been that the high degree carries the day. The late Mr. W. H. Widgery,

for many years an assistant master in the University College School, complained bitterly of the discouraging outlook for even the ablest assistant master unless he had obtained a first-class degree; and of this particular master an obituary notice in the *Journal of Education* said that he would have made an ideal headmaster for the school of the future. Whether this admits or not of remedy, the unsatisfactory result remains that it is of little practical use for an ambitious assistant with a second or third class university degree to make himself master of the theory and practice of his profession, for he can never expect the reversion of the higher offices. Many graduates become schoolmasters because, at the time when they are choosing a means of livelihood, this offers, to begin with, a larger remuneration than almost any other occupation, but if they imagine that their prospects are proportionately bright they soon find how fallacious are their hopes. Promotion is possible only to a certain point: beyond this not even Socrates himself could hope to rise.

(4.) The comparative apathy of teachers towards the scientific principles of their work is largely due to their isolation from one another. It is indeed a relief for the solitary pedagogue to mix with people that are neither pupils nor teachers, and to banish all "shop" from thought and speech. Yet this is carried too far. A man or woman that will never think or talk about professional work when school hours are over is much like the carpenter whom Adam Bede lectures for throwing down his tools at the stroke of the clock. It is true that mere acquaintance with one another in social fellowship would bring few advantages save the counteraction of that spirit of rivalry which is induced by the system of competitive examinations. But the present isolation augurs ill for the advance of educational science. No combined effort is made to investigate problems that continually arise, and it is not improbable that many teachers are ignorant even of the nature of these problems. Individual enthusiasts may break new ground from which the world reaps rich and lasting fruit, but the apathy of the many paralyses the energies of the solitary worker. It may be said that all the advances have hitherto been made by isolated schoolmasters and philosophers; that the work of Pestalozzi and Dr. Arnold is a sufficient vindication of the "single cell" system. But men such as these are rare; and the chance of some genius arising is too slender a thread for the advance of any science to depend upon. The strands of Lilliputian endeavour by the

many may unitedly carry forward the ponderous machine until some Gulliver arise to propel it with the strength of individual genius.

(5.) If teachers themselves are disunited, if not occasionally in mutual antagonism, it is not a matter of surprise that there is no development of public opinion upon educational matters. With the one exception of the vexed question of religious teaching in State schools, it is difficult to specify any important topic on which the general public holds definite and reasoned convictions. It may be urged that there is no need for organised publc opinion on these matters,—that they are best left to experts. But to this objection a conclusive answer is supplied by the fact that in more than one of the colonies (*e.g.* New South Wales and Queensland) the State subsidises or controls a system of secondary education. Whenever this is the case, the system is at the mercy of a minister who may be of a reforming or of an apathetic disposition, and who may or may not have any practical or theoretical knowledge of education. All financial aid given by the State has to be regulated by Parliament, and it is notorious how inadequately this particular State department is discussed and how imperfectly it is understood by Members of our Legislative Assemblies. To questions of educational reform there is little or no support or criticism from expert opinion in Parliament. Since, therefore, public opinion is the greatest force that affects parliamentary action, some effort should be made to interest the general public in the work and problems of teaching.

3. If the foregoing faults and defects of the present system are to be remedied, it must be by the combined efforts, not merely of teachers, but of all true friends of higher education. Teachers themselves can do much : but their ideal is attainable only with the aid of the State, the University, and the educated public. It may clear the ground to mention certain conceivable changes that are undesirable:—(1) The organisation and control of secondary education by the State is not a consummation to be wished. The free play of thought which is induced by a variety of systems would be hampered as by a straight-jacket. Only one channel would remain for introducing reforms, and even that opening would be largely checked by officialism. (2) Secondly, the enforcement of a university degree upon all secondary teachers would be a suicidal policy, at least in the present circumstances of Australian schools. Unless a school is heavily endowed the junior teachers have to be content with

a very modest salary, and the miserable pittance that is sometimes offered drives university men to other occupations. And if all teachers had to be graduates there would be less hope of promotion to induce eniversity men to become schoolmasters. Hence unless the emoluments of the profession become largely increased, such a regulation would break down of itself. (3) Yet, on the other hand, it would be a worse mistake to undervalue academic training and to pay honour merely to the art of brain-development. The higher the scholarship of the staff is, the higher will be the intellectual tone of the school. If the power of imparting is emphasised to the undue depreciation of intellectual culture and store of knowledge, the standard of teaching will inevitably fall, and the knowledge actually imparted will dwindle to its minimum. In any scheme of reform, therefore, the first need to be supplied is a knowledge by teachers of the science and art of their profession.

(*a*.) To speak first of those means of improvement that lie within the reach of teachers themselves, headmasters and headmistresses have it in their power to superintend and to aid the efforts of their staff in self-improvement. An occasional lesson given by the assistant in presence of the head, or *vice versa*, would lead the way to numberless suggestions for amendment, besides providing a stimulus that is often wholly wanting. Further, in engaging an assistant, the principal might very well require a knowledge of educational theory; failing this, he might make it understood that the assistant, if he wished to retain his post, must within six or twelve months pass an examination on set books.

(*b*.) Again, the combination of teachers for technical and professional purposes would be an immense gain to the cause of education. If each colony had its own association—not divided into separate cliques of heads and assistants, but united in common effort as a body of educationists—much investigation might be carried on which is not now dreamt of except by isolated enthusiasts. The aims of such associations should be to increase the professional efficiency of their members, to secure to them the status and privileges of a learned profession, and by influencing public opinion to prepare the way for those reforms which can only be effected from without. Their methods should include frequent discussions of questions bearing on education, lectures (both public and private) by competent authorities, and annual (perhaps intercolonial) conferences.

(*c*.) But, while teachers themselves can do something, the Universities could, if they would, do more. The curriculum of secondary schools is chiefly regulated by university examinations, and those students who profit by university instruction embody the results of the system. The universities therefore have more than a theoretical interest in secondary education. Not only so, the functions of a university—to provide the highest culture in all branches of learning, and to guide the currents of intellectual life in the community—are incomplete without some attempt to propagate the principles on which its own and all other teaching must depend. "If the schoolmaster," says Mr. Fitch, in winged words, "is to become something more than a mere pedant: to know the rules and formulæ of his art, and at the same time to estimate them at their true value, it is to his university that he ought to look for guidance; and it is from his university that he should seek in due time the attestation of his qualifications as a teacher; because this is the authority which can testify that he is not merely a teacher, but a teacher and something else." Therefore the intervention of the university to equip teachers for their profession is no usurpation: it is a loyal recognition of responsibility. What, then, can the universities of Australia do in the special direction of raising the standard of secondary education? (i.) In the first place, each professorial board should include a chair of the history, theory, and practice of education. This is no novel suggestion. Several German universities have for many years included a faculty of Pedagogy; there are in Scotland already two professors of this subject (at Glasgow and St. Andrew's respectively); and in America within the last twelve years (according to Professor Laurie) seven or eight chairs of education have been established. In England no such course has yet been adopted by either the old or the new universities even by way of experiment. The university of Cambridge, it is true, provided lectures in 1879 by Mr. Quick, Mr. James Ward, and Mr. Fitch, but this was a solitary experiment on a small scale, and the Teachers' Training Syndicate, constituted for the purpose, gave no more signs of life when these courses came to an end. On the other hand, the Royal College of Preceptors has maintained a professorship of the science and art of Education since 1873. What work, then, could such a professor accomplish in our colonial universities? For one thing, the influence of such a colleague would be felt at once by the professorial board, and in the courses of study prescribed, as

well as in the examinations held for secondary schools, there would be more conscious reference to educational principles and ideals. The direct work of the professor would be to lecture on the systems, principles, and methods of education, to raise the ideals and help to improve the processes of teachers, to be a representative to state and people of the best thought of the world on the science and art of mental training. (ii.) The practical use of this foundation would be discovered if periodical examinations were held in the subjects connected with it. Courses of study might be arranged for teachers who wish to gain a knowledge of the history and theory of their art, and a diploma granted by a university would have an independent value which would command universal recognition. The practical training of a teacher cannot, of course, be undertaken by a university, nor would a certificate of theoretical knowledge in any way attest personal fitness for a profession which more than any other requires natural qualifications. But this much can be sought from our universities, that just as they safeguard the practice of law and medicine by applying a standard of scientific or technical knowledge, so they should provide a test of theoretical fitness for the art of teaching. (iii.) Among subsidiary means of improving secondary education, the universities might offer annual prizes for essays in some branch of educational science, on the lines of independent thought and investigation. More costly, but perhaps more remunerative in the long run, would be the establishment of an annually awarded travelling scholarship, the holder of which should devote his time to studying foreign systems of education. These are but crude suggestions, and they are certainly not exhaustive. No doubt other and more effective methods might be devised to stimulate higher ambition and more fruitful work on the part of secondary teachers.

(*d.*) But the greatest and most necessary reform, to which all other effort should intentionally contribute, is the (eventual) compulsory registration of teachers possessing a certain minimum qualification. Something akin to the Medical Acts in force in some of the colonies is required to afford to the general public some security against scholastic quacks and adventurers. For this reform teachers alone are not sufficient. The force of public opinion acting through Parliament is alone capable of effecting it. In the earlier days of these southern lands, no doubt it has seemed a pity in any way to check the supply of educationists, for in one

way a bogus education is better than none at all. But surely at our present stage of national development it is an anomaly that any individual who has been a failure in everything else can open a school, as yesterday he opened a shop, without anyone to say him nay. In Prussia it has for many years been illegal for anyone to open a school who has not spent a year of probation in some recognised school, and passed a State-examination in the principles and methods of his art. The regulations (I again use the authority of Professor Laurie, the Glasgow Professor of Education) have now been made even more stringent,—two years of probation being enforced in a "Gymnasium" selected for this purpose. Canada, too, makes preliminary demands upon intending teachers. The Province of Ontario imposes a course of the "History, Psychology, and Methods of Education," as well as a period of practical work in some training college. The imposition of such a test of fitness renders it possible to keep a register of qualified teachers, and affords to the public an assurance that its educators are competent for their important work.

(*e*.) Lastly, the Australasian Association itself may help the cause by elevating education to an independent position as a distinct section. At present it comes in on sufferance, chaperoned by "Literature and the Fine Arts." In the preliminary list of papers to be read before this Association there are included seven bearing on strictly educational topics. If, therefore, this branch of applied science were thus encouraged, without doubt the philosophical, historical, and practical aspects of education would receive greater attention from the whole body of thinking men and women in Australia. An annual Presidential Address would be a distinct boon, as affording a review of past work and a stimulus to further effort.

In conclusion, let us co-ordinate these reforms and see what would be their joint effect. A young man or woman who wished to become a secondary teacher would attend for a year a course of university lectures on psychology, ethics, physiology, and the history and theory of education, receiving at the end, if successful in passing the examinations, a Teacher's University Certificate. During the following year the probationer would practise the art of teaching (including form management) in one of several selected schools, where his efforts would be both scrutinised and assisted by the Principal, who would, in the name of the State, grant a certificate of competency if the year's work were satisfactory.

Possessing these two certificates, the teacher would proceed to have his name registered according to Act of Parliament, upon which he would be free to accept any educational post or to open a private school if he preferred independence. Original research would be stimulated by the enthusiasm of Teacher's Associations, by the annual prize essays, essay prizes offered by the universities, by the attention bestowed upon education by the Australasian Association, and by the improved prospect of attaining the highest posts of the profession. Finally, the purging of the educational system by entrance examinations, and the increased skill and earnestness that would, as a result, be shown by the whole body of teachers, would vindicate the right of education to an honourable place by the side of the other learned professions.

6.—ELEMENTARY SCIENCE IN PRIMARY SCHOOLS.

By J. RULE.

It is not probable that many members of this Association will disagree with me in the general statement that the study of science ought to begin at an early age; and so far it would seem as if I had chosen for this paper a subject upon which there can be little or no room for discussion. Descending, however, from the general statement to questions of detail, such as to what extent, at what age, and in what manner, should children receive regular instruction in science, I anticipate a divergence of opinion sufficient perhaps to justify the subject being brought under notice. And, moreover, it is desirable that the outside public should be reminded of the importance of science being allowed a prominent place in primary school work; for hitherto an acquaintance with words, alone or associated with a little hearsay information about things, and a certain degree of mechanical skill in the processes of arithmetic, has been looked on by too many as the main object desirable in education.

But before entering into details, it may be perhaps as well to show cause for recommending the study of science as a part of elementary education for *all* children—those of the labouring classes as well as those who, by reason of their parents' wealth or position, may seem to have in prospect a

life of learned leisure or a professional career. In doing so it is only necessary to mention that, beside the probable future need, which many will realise, for exact scientific knowledge as a basis for technical training in the different occupations to which they betake themselves, there is the broad truth that the well-being of every person depends largely on the regulation of his life and conduct in accordance with the laws of nature; and that not only is the individual's own submission to these laws necessary on his own account, but that in addition his welfare is affected in many ways by the life and conduct of his neighbours and fellow citizens. So it follows that for the good of society at large it is desirable, not merely to spread the truths of science as widely as possible, but also to encourage among people generally the spirit of scientific research; as the more seekers there are for undiscovered truth, the greater hope will there be of finding it. We are still very far from having learned all that should be known concerning the physical, chemical, and vital properties of the different kinds of matter, organic and inorganic, in the midst of which we live and move and have our being; especially with regard to their capabilities of directly hurting or benefiting the human organism, or of doing so indirectly by helping or hindering the growth of those animal and vegetable organisms on which we depend for subsistence.

In determining what in the way of science should be taught in primary schools, it is necessary to consider what subjects are most suitable to the children's immature mental powers, as affording the best kind of discipline for their development, and to take into account the comparative usefulness of the different kinds of knowledge in subserving human wants. It is obvious that anything like abstruse reasoning is altogether out of place in a curriculum for young children; as is likewise every subject concerning which a comprehension of the data implies a mental development or an experience of life impossible, or at least undesirable in childhood. But most of the concrete sciences have their foundation in facts, easily cognisable by very young children. So, without their minds being burdened with any elaborate terminology during the early years of school life, they may quietly, without any brain-oppressing effort or stimulation to premature development, acquire a large stock of knowledge, more or less organised, concerning common things and phenomena that come frequently under their notice, and so have a groundwork laid

which will serve them in good stead when in the higher of the school classes they come to study the different branches of science more fully. It goes without saying, that in order to ensure children's education being real and not mere instruction or cram, no managers and teachers of the Gradgrind and Chokemchild type should have control of primary schools. But such types are now happily uncommon.

As to the time when children might profitably begin to learn science, I consider that under properly qualified teachers, who know how to respect mental as well as bodily weakness in the imposition of burdens, there is no reason why scientific education should not begin in the nursery or Kindergarten; where, rather in the way of amusement than by set lessons, clear notions may be gained by children about things that can be seen, handled, and compared; curiosity may be excited; and the instructive tendency to generalise and to trace causes may be developed and directed. I do not mean it to be implied that children should be instructed about nothing beyond what they can see, hear, handle, or taste. It is essential that the faculty of imagination should be exercised within due bounds. It is good for them to be helped in forming some clear conceptions about many things that cannot be brought bodily under their observation. For this purpose a plentiful supply of pictures will be found useful; and, with or without these, graphic descriptions should be given in easy language, care being taken to assist their conception of the unseen as far as possible by comparison with things they have seen. Nor is it desirable to occupy so much of the children's time with the beginnings of science, as to leave too little for the beginnings of literature. Nursery rhymes and easy poetry, the learning of which is objected to by many parents as a waste of time, have important uses, as likewise have fables and interesting stories of adventure. Recitation of rhymes and poetry is a valuable exercise for developing clearness in the articulation of words. Fables and stories, in the reading of which no stress is laid on remembrance of the subject-matter, give the imagination scope, and afford a good relaxation from more serious work; while facility in the art of reading is acquired pleasantly, instead of painfully. But even the subject-matter may sometimes be turned to good account. For instance, a beginning might be made in developing the critical faculty, by leading children in a humorous way to perceive little Jack Horner's mistake, when he thought, as the rhyme seems to

imply, that finding a plum made him a good boy. It may be remarked by the way that Jack's mistake was perhaps more excusable than that of some teachers, who, confounding goodness with cleverness or luck in guessing, reward the giver of a correct answer by exclaiming "That's a good boy!" But these remarks are somewhat beyond the purpose of this paper, which is not supposed to treat of literature, ethics, or general school management.

As children advance beyond infancy, and their experience widens while their mental powers develop, their knowledge should gradually assume more and more fulness and organic form; though not until they reach the higher classes, that is to say, not before the age of eleven or twelve on an average, can they be reasonably expected to go any great length in the study of those branches of science in which calculation or mathematical reasoning is required. However, during this middle period of primary school life clear views and a large stock of interesting and useful knowledge in most of the exact sciences can be acquired, as well as in those that depend mostly on observation and comparison. To this end it is essential (1) that in every school one or more of the teachers shall have been well trained in scientific methods, not merely crammed with facts and explanations gathered from text-books in order to pass an examination; and (2) that every school shall be well provided with material to illustrate the lessons.

If so far children have been properly trained in arithmetic and elementary geometry with a little algebra, it may be expected, if they do not leave school too early, that by the age of fourteen or thereabout they will have laid a sure foundation for future self-culture in a scientific direction; while such subjects as history, literature, &c. have not been neglected.

With young people who have gone systematically through a good primary school course of science, technical school teachers will have only their proper work to do—that of training them in the application of scientific knowledge to the useful arts and industries of life, instead of having to begin, as they frequently have to begin at present, with the very ABC of that knowledge. I may here mention an extreme case which came under my notice, when there were no technical schools in Hobart, and young men had to seek technical instruction from private teachers. A young seafaring man, wishing to master the processes of trigono-

metrical calculation in a few days in order to qualify himself for the position of mate, sought the assistance of a private teacher, who hoped to be able to let him see clearly the use of logarithms and simple formulæ, but was staggered on finding his pupil ignorant of the process of simple subtraction. Not only to technical school students, but to all who grow up to be men and women, the knowledge acquired in primary schools will be found of great value. Those who become medical students will enter upon their professional training much more intelligently through having already gained a preliminary acquaintance with anatomy and physiology. Those who become agriculturists or horticulturists will find what they already know of physics, chemistry, and biology of great advantage; and even in the absence of teachers they will be able by the aid of books, with observation and experiment, to make headway in acquiring more knowledge as they find it needful. Even those who become tradesmen, without a previous training in technical schools, will be found much more efficient through having had a good primary school training before apprenticeship. Those, too, who join the ranks of what is commonly called unskilled labour, will be found more efficient labourers through having learned something of mechanism and statics. It is not uncommon to find strong men, ignorant of the properties of the lever, spending their strength to little purpose by applying it near the fulcrum. But it is unnecessary to enumerate in detail all the advantages that might be expected from the elements of science being taught effectively in primary schools. I will only add that housewives and domestic servants would be more likely, with a knowledge of hygiene, to keep their houses wholesome, and to cook better dinners after having learned the chemistry of the kitchen. Also that mothers, who know something of physiology, would be less likely to make such mistakes as are now only too common in the feeding and clothing of children.

Having thus roughly sketched what is desirable, and ought to be found practicable, with regard to science in primary schools, I feel it incumbent on me to give an account of what we are doing in that direction in Tasmania. But I enter on this part of my paper with a considerable degree of reluctance. The account to be given is not a cheerful one; and no one likes to incur the obloquy commonly thrown upon an "*ill bird*."

The great majority of primary schools in Tasmania are

State schools. The percentage of children under fourteen who are educated in denominational and private schools is very small. Most of the schools for boys and girls whose parents are wealthy, or in easy circumstances, supply both primary and secondary education, having junior and senior departments. Only in a few of these schools is there systematic science teaching in the lower department; though in the higher department of several there is good teaching, especially in the exact sciences, for those pupils who choose to avail themselves of it. In the schools for girls of the same grade of society matters are not so satisfactory. In the majority little or nothing that can be called science teaching is attempted, except, pehaps, task-work in catechisms *de omnibus rebus.* It is wonderful how many teachers still believe in catechisms, forgetting, or perhaps never having recognised the truth, that children may be trained to repeat glibly the stereotyped answers to set questions, without even a glimmering of real knowledge in the subjects they are expected to be thus learning.

In the private and denominational schools, attended by children of the working classes, as well as in the great majority of the State schools, little or nothing is attempted in the teaching of elementary science; although for the higher classes of the latter it is included in the "Standard of Instruction." Only a small minority of the teachers have had the training requisite for such teaching; while, except a limited supply of specimens and apparatus in the model school, and a few charts illustrative of natural philosophy, zoology, &c., in that and the other large town schools, there is no material provided to assist them in the work. As may naturally be expected, only a small percentage of the few qualified teachers, who are thus hindered in their work by the want of apparatus, are sufficiently zealous to provide it at their own expense. Those who are skilful in using chalk on a blackboard, and are ready in improvising makeshift arrangements, can do a great deal in helping children's conception, but not sufficient to dispense with proper apparatus, specimens, &c. The ordinary "object lessons," which should supply some little instruction in science, are too often no better than mere words, conveying at the best very inadequate ideas of the subject supposed to be taught.

To sum up this account of elementary science teaching in the primary schools of Tasmania, it may be stated that, except in a small percentage of the schools, there is virtually

no provision for such teaching—the absence of teachers qualified to undertake it being the most vital defect in the schools' organization; while the want of proper appliances for most of those who are qualified, renders their teaching more or less ineffectual.

7.—THE SCIENTIFIC METHOD OF STUDYING LANGUAGES.

By R. T. ELLIOTT, M.A.

An attentive observer can hardly fail to be struck by the very poor results in regard to the acquisition of languages attained by present methods, especially in schools. We find everywhere boys and girls who have spent a large proportion of their time during six or even ten years of school life in learning Latin or French, and who yet cannot translate half-a-dozen lines of Virgil at sight correctly, or write half-a-dozen lines of French prose without some gross blunder. On the other hand, we not infrequently find boys and girls, after spending six months in France, able to read and write French not only with fluency but with correctness. The contrast is startling, and cannot but lead us to reflect whether there is not something scientifically wrong in a system which leads to such poor practical results.

A scientific method of study is one which corresponds as far as possible (1) to the nature of the object to be studied, and (2) to the nature of the subject that studies.

There are two methods of studying a language: (1) the deductive method—theory before facts; and (2) the inductive method—theory from facts.

The method at present most popular is essentially deductive. The theory of the language, *i.e.*, grammar, is insisted on long before a practical acquaintance with the language is obtained. In Greek and Latin especially an altogether disproportionate importance is assigned to grammar. The unfortunate learner of Latin, for example, goes a ceaseless and weary round of forms which to him are to a large extent meaningless, learns the genders of dozens of words whose meaning he does not and never will know, and the parts of dozens of irregular verbs which will never occur in the course of his reading. Then for a long time the only literature he reads consists of short and wearisome sentences, such as "Balbus builds the wall." Simultaneously he is

expected to put similar beautiful and inspiring thoughts into Latin, which he does, thereby stereotyping his own ignorance and blunders. After a year or so thus spent, he goes on to read Cæsar, which he naturally views as a mere meaningless assortment of irregular verbs and variegated subjunctives, cunningly devised for the express purpose of puzzling English-speaking schoolboys. Over all looms the gloomy spectre of some examination, and, this once over, many a boy leaves his Latin or French or German for evermore, and in a year or two cannot read two consecutive lines of the language he has studied. His study of the language has been dull and wearisome throughout, and leaves as much permanent impression as a child's footmarks on the sea-shore. Can this result be called satisfactory?

Quite apart from the dry-as-dust character of this method of study, it is an unscientific method. (1) It does not correspond to the nature of the object to be learned, for in the enormous weight it assigns to grammar it practically identifies language with grammar, and grammar is not language, but merely analysis of language. Hence a person with no knowledge of grammar may be able to speak a language correctly, while a person with a thorough knowledge of the grammar of a language may be unable to speak or even write the language at all. Language is the material, grammar the analysis of the material. Let us get together a good amount of material first, and gradually learn to analyse it afterwards, as we have need, instead of arming ourselves with a superfluous weight of weapons with which to attack a phantom which does not yet exist. (2) This method does not correspond to the nature of the subject that learns, especially in the case of children. The young mind finds it very difficult to grasp abstractions, and the process of starting from the abstract and going on to the concrete is the reverse of the natural order. The unnaturalness of attempting to learn a code of abstract propositions about a language at a time when the learner knows practically nothing of the language itself, is shown by the fatal facility with which these rules are again and again forgotten by the victim, as any practical teacher can testify. Again, the logical order of grammar is often not the order natural to the learner. Take Otto's German Grammar for example. Everything is arranged in perfectly logical order with all the rules and exceptions and exercises on every one; and what to the learner is the practical result? Why, he has learned, or rather forgotten, dozens of minute

rules about words and constructions that hardly ever occur; but it will actually be a year, or perhaps two years, before he learns the order of words in the simplest sentences of every-day life! The natural result is that the learner loses all sense of proportion, and in trying to remember all remembers next to nothing.

Before proceeding to consider whether there is not another method at once more natural and more effective, let us ask ourselves how does the child learn its mother-tongue? Does the mother begin her lessons in English by teaching her child the declensions and irregular plurals, then going on to the regular and irregular verbs, and giving suitable exercises on each rule? Nothing of the sort. The child hears words and sentences frequently repeated, and made more or less intelligible by gesticulation and the tone of voice, and thus gradually comes to understand them. Its knowledge of grammar comes gradually and unconsciously. This is the natural method. It is of course impossible to reproduce this method entirely in learning a foreign language, but it is well to bear it in mind.

The system I wish to advocate is an inductive method. The chief fault of the prevailing system is that in the initial stages there is too little teaching. Instead of being taught something as a basis, the unfortunate learner is expected to manufacture knowledge for himself. The initial stages of the method I would advocate may be put very briefly. The student need not yet buy a grammar or a dictionary. Let the teacher in Latin, for example, at the outset choose some easy and interesting anecdote from Cicero or Livy and write it on the blackboard, first telling his class the general meaning, and then translating it word for word, telling them the exact meaning of each word, and pointing out the likeness to any cognate English or French word that they may happen to know. When the piece is thoroughly understood, let the scholars themselves write down an exact translation of it. After correction, and after some interval, let the reverse process take place; let the English be given them, and let them learn the original Latin off by heart, which, as it is now thoroughly known, will be a very easy matter. The next lessons would be similar. Meanwhile, the learner's curiosity will gradually have been awakened. In the pieces he has learned by heart he will have noticed several parts of the same word in slightly different forms—*e.g.*, *Filius patrem amat*, but *Pater filium amat*. Already, by an unconscious induction, he has a

rudimentary knowledge of declension, and remembering, from his examples, forms like *filius*, *filium*, *filio*, &c., he will find it easy to learn the whole declension intelligently. As he goes on, under the judicious help of the teacher he will gradually find out more and more for himself—among other things, that in Latin the verb generally goes at the end of its sentence. Great judgment should be used by the teacher in choosing carefully graduated sentences. Having now got fairly started, with constant revision, and having now a fair basis of vocabulary, the pupil may be allowed to learn with every lesson a little grammar, based as far as possible on his actual reading. Parsing may now be introduced, and when he has seen a fair number of subjunctives, and his curiosity has been judiciously aroused, the teacher will gradually explain the reason of the most important subjunctives, illustrating from the examples already learned. In this way the whole of the grammar may be naturally and pleasantly acquired *pari passu* with the process of translation. On no account should a dictionary be used in the early stages. To the young beginner a dictionary means sheer waste of time—the loss of many precious hours in the mere mechanical labour of turning over the pages, and in the wearisome and at early stages merely fortuitous task of selecting one of perhaps a dozen meanings for three or four words in a single sentence. Till the scholar is well advanced the teacher should be his dictionary, and the time thus saved can be utilised in extending his reading and in committing to memory what has been already learned; while the teacher, who ought to have a sound knowledge of comparative philology, can greatly aid the acquisition of new words by linking unknown words to known, and by pointing out the cognate English, French, or German words. As the time goes on, the teacher will encourage his pupils to rely more and more on themselves in translation. As the pieces become longer it will not be necessary to learn by heart the whole piece; translation and retranslation (even partial) with revision will ensure a thorough knowledge. In addition to the literal translation an idiomatic English version should now be given, and by retranslating the latter the learner will insensibly acquire an intuitive perception of the differences between Latin and English idiom. The teacher may now introduce Latin prose and conversational Latin, at first closely modelled on the Latin that has been read, but gradually, as the learner's knowledge extends, becoming more and more independent. In the long run this will be found a far more

effectual way of learning to write real Latin prose than the popular method of starting with what is by courtesy called Latin prose at a time when the learner has read practically no Latin at all.

A similar method with some modifications may be applied to private study, though undoubtedly a language is better learned under a good teacher. Instead of wading through a grammar book and exercises, the student should start, if possible, with an edition of an easy author which contains a word-for-word translation and every word fully parsed—*e.g.*, for Greek and Latin the *Analytical Classical Series*, for Hebrew *Bagster's Student's Manual*, and for Sanskrit the *Nalopâkhyânam* (Clarendon Press). For languages where there are no such series to be had, I would recommend the student to start with the Gospels, which are published in over 250 languages by the Bible Society. The process of retranslation and learning by heart could still be pursued, and, as time goes on, the whole of the grammar may be gradually acquired *pari passu* with the reading. The progress made under this method will be found to be far more rapid and permanent, to say nothing of the process being infinitely more interesting, than under the grammatical method.

I must express my firm conviction that children taught under the inductive system sketched above would acquire far more real knowledge of a new language in two years than they acquire in six years under the current grammatical system. The process of learning is interesting and delightful throughout; it is the most natural method, since it is far more in analogy with the process by which we acquire our mother-tongue, and knowledge of the language precedes analysis of the language; moreover, it stimulates the thought of the learner throughout far more than the grammatical method. Lastly, this method would be especially valuable in the case of the large class of boys and girls leaving school about 16. Under judicious teaching they would at any rate be able to carry with them as a permanent possession some of the noblest and most beautiful passages in the language they have been studying.

Objections may, perhaps, be urged by those who have had no practical experience of the inductive system—(1) It may be urged that it requires better teachers than the majority of those we have at present. I quite agree, and consider this one of its main advantages. (2) It may be said it requires to be tested by experience. The inductive

method has already been tested by experience, and proved fully successful. It is being, I believe, increasingly used in America with great success. One of the most successful teachers of modern time, Roger Ascham, advocates it as the result of his own experience, and it was on this system that he brought to such a high level of scholarship at an early age Lady Jane Grey and Queen Elizabeth. (3) It may be objected that independent composition is deferred. No one believes more firmly than myself in the mental value of Latin prose composition, but I do not believe in attempting to make bricks without clay. It is surely better for the student to read and learn by heart a fair amount of real Latin first, instead of manufacturing bad Latin from the outset. For instances of the bad effects of premature composition we have only to look at the fearful and wonderful results of so-called conversational French in girls' schools, or to think of the under-graduate who, after several years devoted to Latin under present methods, translated "I am given to understand" by "*Intelligere dor.*"

In the more advanced stages of learning, the scientific grammatical and historical analysis of language will assume increasing importance. (1) The first reform needed is a homogeneous nomenclature. The multiplicity of different names for the same thing causes endless confusion and waste of time to the learner—*e.g.*, the tense implied in "I went" is called in Greek the aorist, in Latin the perfect, in French the preterite definite, in German the imperfect, in English the past, in Sanskrit the second preterite, and in Hebrew in certain cases the future! Can we wonder if the unfortunate student is bewildered? (2) Where several languages are being learned simultaneously they should be taught as a whole, with due regard to their mutual relations. The essence of science is comparison, and therefore the essential of a scientific method of learning languages is that it should be comparative. In other words, though results of high educational and practical value may be otherwise obtained, it is an absolute impossibility for any language to be learned scientifically, in the truest sense of the word, apart from comparative philology. Nothing can be understood when viewed by itself, but only when viewed in its relation to other things. I am aware that many teachers allege that comparative philology cannot be used in practical teaching in schools; but it will, I think, generally be found that such objectors know nothing whatever about comparative philology.

The fact is, that the languages commonly taught in schools—Greek, Latin, French, German, and English—are in their essence one language, and if they are to be learned scientifically they must be learned and taught with due regard to the fact of their unity. I do not, of course, advocate teaching the phonetic laws of a language from the outset; the learner must have acquired a fair practical acquaintance with the language first. But from the outset the progress of the learner may be aided by the judicious use of the comparative method, especially in regard to vocabulary. The most scientific as well as the easiest mode of learning new words is by means of their derivation and cognate words. In Latin, for example, there is hardly a word that has not some cognate word in English or French. The vocabularies of these languages should, therefore, be learned as far as possible in common. Hence, to teach French quite apart from Latin, as is so often done, is quite unscientific. If, on the contrary, a boy is taught that French *penser* is derived from Latin *pendo*, and properly means to weigh in one's mind, he not only learns a scientific fact, but, if he forgets one word, the other will easily recall it to his mind, and he is far more likely to remember both than if he had learned each word separately as though it had no connection with the other. But it is not in mere isolated derivations alone that the scientific value of comparative philology lies. The student must be led to perceive that language is subject to laws as uniform as those which govern other natural phenomena, and that all exceptions (even in English) are only apparent. When he has learned that Latin *tres*, *tu*, *tenuis*, *tono*=English *three*, *thou*, *thin*, *thunder*, the teacher may lead him by an easy induction to recognise the phonetic law that Latin initial *t*=English *th*, and encourage him to find other examples and also apparent exceptions. Again, Latin *nigrum*, *minus*, *fidem*=French *noir*, *moins*, *foi*; that is, Latin *ĭ*=French *oi*. Simple phonetic laws like these may be taught to boys and girls at school with advantage. Quite apart from their scientific value, they stimulate the mental faculties of the learner and render the acquirement of a larger vocabulary at once more easy and more permanent.

If comparative philology is useful at school, in the university it is indispensable for any really scientific study of languages. For literary and practical purposes a language may perhaps be studied very well without its aid; but literature and convenience are not science; and, just as no one can be said to

have a scientific knowledge of astronomy unless he knows the laws that govern the motions of the heavenly bodies, so no one can have a really scientific knowledge of any language unless he has an accurate knowledge of the phonetic laws that permeate that language. At present to many this statement will seem a paradox; the next generation will regard it as a truism. The truth of it is every year being increasingly recognised. In many Continental universities no student is allowed to take a degree in any language, whether Latin, French, or English, without passing an examination in comparative philology. Already in Melbourne University no student can take honours in Greek and Latin after his first year without passing in comparative philology; and it is earnestly to be hoped that the same obligation to scientific study will soon be extended to English, French, and German, as is, I believe, the case at Cambridge, so that it may no longer be possible for a student to take honours in English who is ignorant of the simplest laws that govern the development of his own mother-tongue. It is especially in regard to English that the need of reform is most manifest; indeed, the present neglect of the scientific study of English by all but a few experts is a disgrace to the English race.

In conclusion, I would appeal to teachers to give the method sketched above a fair practical trial. The inductive method of teaching is not a mere theoretical novelty; it has been advocated and employed with the highest success by some of the ablest teachers of modern times. Undoubtedly it demands much more work and skill from the teacher than the grammatical method, and secondary teachers at present are mostly overworked and underpaid. I admit also that in its initial stages the method would not pay in certain popular examinations, though even here it would pay in the long run. But the end of education is not examination; indeed, sometimes examinations, as in the case of the Melbourne matriculation, may be a curse to education. I appeal only to those who care for education. I believe that the method I have sketched is not only the most scientific, but also the most interesting to the learner, and the method which will in the long run produce the most practical results.

8.—THE MODERN LYRIC, FROM A MUSICAL STANDPOINT.

By MISS EVELYNNE MILLS.

THE song is to music as the flowers are to Nature, not perhaps its most important feature, but still a very helpful and necessary component. The mission of each is, or ought be, to soothe, to interest, to gladden, to bring out whatever there is in us of the power of admiration, which, after all, is very closely akin to adoration or worship—the highest of our human faculties.

It was late in musical history when the song reached perfection, perhaps for the reason that the great musicians had been much occupied with the larger branches of their art, and it would seem that every separate department of an art needs the special attention of at least one master-mind to bring its shadow-hidden possibilities into the sunlight of reality.

In every good song the words are the first consideration, and we may say that the model lyric contains five great essential points:—1, Verbal simplicity; 2, Verbal grace; 3, Contrast of idea; 4, Brevity; 5, An effective conclusion. I use the word lyric in its original sense of a poem written to be sung by one voice to the accompaniment of one instrument.

1. *Verbal Simplicity.*

The necessity for verbal simplicity is a point so often overlooked by modern poets, that numbers of otherwise suitable songs must be rejected by musicians simply because they contain words too long to be sung in solo without producing a clumsy effect, or one of undue hurry. As a general rule, words of more than three syllables are out of place in a lyric. The reason for this is that in all music, whatever the measure, the accents fall either on every alternate or every third note. The beat is either ONE two, ONE two, or ONE two three, ONE two three. All modifications of "time" can be ultimately reduced to one or other of these primary rhythms. In listening to a song the ear is irritated if the syllables of one word are spread over many of these pulses or beats, though there is no objection to the sustaining of a single syllable for an indefinite period.

Another reason is, that in ordinary conversation we

naturally utter a word of, say, five syllables more quickly than five words of one syllable each, and this cannot be done in song without interfering with the symmetry of the music. Take, for example, these five words "A good house well built" and the single word "unwarrantable." The number of syllables is the same, but if we sing the five words to some simple melody, such as the hymn-tune "Hanover," and then sing the five-syllabled word to the same tune in exactly the same time, the effect is ludicrous. We see at once that our ordinary practice is to hurry over a word containing many syllables.

We must also recognise the fact that a lyric, however artistically written, composed, and performed, has natural and necessary limitations. It is too much to expect a single voice, accompanied by a single instrument, to do justice to themes for the expression of which the varied resources of chorus and orchestra may be adequate. No one man can make an effective cheer, however strong his voice, and however fervently prolonged his hoor—a—y. The impetuous patriotism of the "Marseillaise," the religious ardour of the Hallelujah chorus, the profound philosophy of "Consider, consider whether to excel be worthy thine endeavour," the realistic militarism of "We'll follow the Bourbon," the wild descriptiveness of "Now the storm-blast came," though effective in chorus, would be entirely out of place in solo. Poets and musicians must remember that elaborate themes require elaborate treatment.

2. *Verbal Grace.*

If we do not expect in a song any very great depth of thought, there is all the more necessity and opportunity for elegance of diction.

Hard-sounding words, even if they express a tender sentiment, are not pleasing when sung. And it seems almost unnecessary to say that hard sentiments should be left out of lyrics altogether. And yet we find, in a recent volume of German Lieder, this dreadful stanza in a song of revenge:—

> Right in my way thou comest,
> Thou scoundrel, wilt thou dare?
> Thy dagger-thrust is parried, now worthy friend "Good Lack!"
> How on the foreign brain-pan the German sword does crack.

The only excuse for the musical utterance of such words would be the requirements of opera.

This also from the same source :—

> "And I must to my home repair
> For *books and pen* await me there,
> Adieu, Adieu,"

is too prosaic to sound well in song.

I have chosen two examples of modern lyrics, which appear to me to be simple, graceful, and finished. The first is from an English volume, by the author of "Meadowsweet":—

> I saw a weeping maiden
> A-searching in the morn
> For love that's half a rosebud,
> For love that's half a thorn;
> She sought him on the hill-top
> And o'er the dewy lea,
> But he was standing in the shade,
> Was waiting there with me.
>
> He sang not in the meadow,
> He piped not near the stream,
> Nor hid in ferny forests,
> The darling of her dream;
> He lurked not in the poppies,
> He shone not in the sky,
> But called to her from out my heart,
> And yet she passed him by.

The second is from Mr. P. J. Holdsworth's "Station-hunting on the Warrego":—

> In the warm flushed heart of the rose red west,
> Where the great sun quivered and died to-day,
> You pulsed, O Star, by yon pine-clad crest,
> And throbbed till the bright eve ashened grey;
> Then I saw you swim
> By the shadowy rim,
> Where the grey gum dips to the western plain,
> And you rayed delight,
> As you winged your flight
> To the mystic spheres where your kinsmen reign.
>
> O! star, did you see her? My Queen of Dreams!
> Was it you that glimmered the night we strayed
> A month ago by these scented streams,
> Half-checked by the litter the musk-buds made?
> Did you sleep or wake?
> Ah! For love's sweet sake
> (Though the world should fail, and the soft stars wane),
> I shall dream delight
> Till our souls take flight
> To the mystic spheres where your kinsmen reign.

3. *Contrast of Idea.*

The skilful introduction of contrasts is one of the fundamental duties of all true artists. Our complicated natures must be appealed to on all sides. We need shadow as well as sunshine, rebuffs and encouragements, drudgery and congenial occupation, anxiety and hope, sorrow and joy, work and rest, adversity and prosperity, in order to draw out all our powers and complete our experience. The artist understands that the play of human emotion is as varied as the contour of the clouds or the currents of the sea, and he realises that his art also, if it is to express or appeal to human emotion, must be varied, mobile, objective.

In Schubert's setting of Goethe's "Erl King" we have a fine example of the power of contrast. As Dr. Parry says, "Schubert gives the impression of the wild elements, and of the headlong career through the night, the terror of the child, the anxiety of the father, and the mocking summons of the Erl King, and combines it all in sounds which rush with excitement ever increasing from moment to moment, till, with their arrival at the door of their home, the music, like their headlong career, stops suddenly, and in a stillness of despair, the father's horror at finding his child dead in his arms is simply told in six quiet words."

4. *Brevity.*

A song must not be long. In these days of abbreviated novels, short sermons, reduced hours of labour, and epitomes of everything, it is only fitting that our songs should be condensed, and that the long-winded anecdotes in poor verse, which used to do duty as songs, should be "rolled up in cotton wool and gum camphor, and placed upon the back shelf of historical memories." When we take up an old song-album and find that the majority of its numbers consist of about four or perhaps eight lines of melody with a monotonous accompaniment, to which are set some ten or fifteen verses of uninteresting poetry, we are amazed at the patience of our forefathers. The music written for the first verse was required, like a family umbrella, to be at general disposal, and was expected to take any number of "lines" under its friendly protection. The accompaniment was there, a fixture, and the words had to adapt themselves to it as best they might. The modern method aims at the reverse of this. The music takes its cue from the words, sympa-

thetically following them wherever they may lead, and really repeating them in the "language of emotion."

5. *An Effective Conclusion.*

"The tones of first impression," as Curwen calls them, establish the key and the rhythm, and give a clue to the general motive of the song. The tones of last impression determine the mental effect of the composition as a whole. For the memory retains the last phrases more readily than any others, and according as they are grave or gay, the prevailing idea of the song will be grave or gay. But whatever the mode or tempo, it is necessary that there shall be an air of definiteness about the conclusion; and here, as elsewhere, the words are all important. A verse which is fairly good, but in no way more noteworthy than its predecessors, or which gives the impression that there is something more to say, will never do for the conclusion of a song. And, unfortunately, so many lyrics end in this fashion. The end should come as soon as possible after the words have reached their climax. Nothing more is needed but a few resolute finishing strokes.

Of the great English poets, Tennyson stands undoubtedly at the head of those whose songs have found favour with musicians. His "Sweet and Low" is one of the most charming lullabies ever written, while "Home they brought her Warrior" is a powerful example of the narrative song, and exquisite love poems are scattered broadcast throughout his works.

Both Browning and Swinburne have written strangely few lyrics that can be set to music. Both possess the secret of writing musical poetry, but neither seems to have studied the musical conditions of to-day. Both make the same mistake—of putting too much under one heading. For this reason nearly all of Browning's powerful "Dramatic Lyrics" are useless to musicians, and Swinburne's beautiful "Ballads," dramatic choruses, and "Songs of the Springtide" would exhaust the patience of any 19th century audience.

The poems of Mrs. Browning were for many years an almost untried field to musicians, but Maude Valerie White has shown us that the "Sonnets from the Portuguese," at all events, are capable of effective musical treatment.

In the works of Lewis Morris there are many lyrical gems, and some of the songs in "Gwen" are as dainty and sweet as we imagine Gwen herself to have been, but, as far

as I know, none of his songs have yet been set to music and published.

The Australian poets have so far done but little in this field. Like the musicians before the time of Schubert, they have turned their attention chiefly to larger productions, and though their lyric poems are graceful and rich in poetic fancy, yet they are so few in number as to seem almost accidental. We still look to the future for the mighty men who will do for Australia that which Goethe, Schiller, and Heine have done for Germany; which Burns has done for Scotland and Longfellow for America; which Tennyson, Morris, Bridges, Rossetti, and many others are doing for England. For, to slightly alter Kendall—

The song that still we dream about,
  The tender, touching thing,
As radiant as the rose without,
  The love of wind and wing;
The perfect verses, to the tune
  Of perfect music set,
As beautiful as afternoon,
  Remain unwritten yet.

9.—THE PROVINCE OF THE AMATEUR IN ART.

By REV. C. H. DICKER.

10.—THE AUTHORSHIP OF SHAKESPEARE'S PLAYS.

By F. J. YOUNG, B.A.

11.—SHAKESPEARE AND BACON.

By C. M. TENISON.

12.—THE RATIONALE OF EXAMINATIONS.

By F. J. YOUNG.

13.—TENNYSON'S POETIC RHYTHMS.

By PROFESSOR WEBB.

14.—THE AUSTRALIAN DECORATIVE ARTS.

By J. R. TRANTHIM-FRYER.

15.—FORMATION OF HOME READING UNION.

By BISHOP OF TASMANIA.

Section J.

ARCHITECTURE AND ENGINEERING.

PRESIDENT OF THE SECTION:

MR. C. NAPIER BELL, C.E.

1.—THE WATER SUPPLIES TO RURAL TOWNSHIPS IN TASMANIA.

By C. WORDSWORTH JAMES, Assoc. M. Inst. C.E.

TASMANIA is divided into eighteen counties, and these counties are subdivided for the purposes of local government into nineteen rural municipalities and fourteen police and municipal districts. The latter are more immediately under the control of the Central Government, but with certain conditions can be constituted into rural municipalities.

There are two cities, one hundred and eleven proclaimed towns, and four hundred and twenty-five villages or settlements.

Of the one hundred and eleven towns only about 50 per cent. are of any consequence, the remainder exist pretty much in name only. This is frequently the case in the colonies. Townships have been laid out and proclaimed, and allotments have been sold at a period, perhaps, when there was every promise of a rapid growth and settlement, owing probably to local mineral discoveries or other anticipated sources of industry. The promised "Eldorado" has proved a failure; the locality is deserted and allowed to subside almost to its normal state. Several so-called townships in Tasmania can boast only of a dwelling or two, others, to the author's knowledge, showing nothing but a single cottage or a deserted and ruined hut.

The two cities of Hobart and Launceston enjoy their own water supplies in fair abundance. The former city is enabled to extend its supply to *four*, and the latter to *two* suburban towns. Besides these there are only a few of the remaining towns that are provided with a local permanent supply. That at New Norfolk is the only one where any system of water supply by gravitation is conducted, and that was probably undertaken on account of its being originally a government

settlement, and containing, as now, a large public institution. The old penal settlement at Carnarvon, Port Arthur, has also a supply, which is now very much out of repair.

In another town local enterprise has been strongly enough supported to raise a loan for conserving water. What was formerly a large swamp has been transformed into a lake covering an area of twelve hundred acres, with an average depth of fifteen feet. This lake forms the source of the river flowing through the town, and secures for the residents a copious supply all the year round. The water has, however, to be carted from the river when required. An enterprising individual has also erected pumps and tanks, and laid down mains in the principal streets. Water is supplied therefrom at so much per tap, the consumer paying the cost of attaching a service to the house when he feels disposed to adopt it.

Then there are twelve townships in which it is contemplated to institute new local systems of water supplies, and Acts of Parliament have been applied for and granted in one or two instances. The majority of these are gravitation schemes, whilst others resort to pumping, either by steam or water power. Many of these schemes, however, are in a state of embryo, but it is satisfactory to note that residents are awakening to the necessity of providing themselves with an adequate supply of water, not only for domestic use, but also for sanitary purposes and protection from fires. Accepting as a probable fact that the above twelve towns will have supplies, or are contemplating having them, there yet remains a large number of more or less consequence inadequately provided with water, to say nothing of over fifty so-called towns, and no less than four hundred and twenty-five villages or settlements, which in all likelihood will be left to their present resources for many years to come.

They may never require any alteration in their present system of obtaining water, but should unforeseen circumstances arise further developing them and bringing them into importance, then, probably when it is too late, it will be discovered that the most accessible and economical means of obtaining a supply has been overlooked, and a serious and expensive difficulty has to be encountered in finding a new and suitable one. Useless regrets and condemnations will then be expressed reflecting on the central or local authorities in not having provided for any such emergency.

As a rule all settlements, villages, or towns are located in close proximity to a supply, more or less, of Nature's first

essential of life—water; but whether in all cases that water supply is a good one, both in quantity, and particularly in quality, is another question. If a river or stream it may possibly become polluted by drainage or mining operations, and what is a fairly pure article for consumption and use to-day may in a few years prove totally unfit for domestic purposes.

Residents in small towns not possessing the advantage of an adjacent stream or river, are dependent upon rain-water caught from the roofs of their houses and conserved in tanks. There is no objection to this method, provided the rainfall is frequent, and that the tanks are sufficient in number or size, and regularly examined as to cleanliness; but we so often find the storage of rain-water totally inadequate to the requirements. Occasionally an old packing-case or a barrel is made to answer the purpose, and perhaps does so during the winter months, and even then how frequently we find these temporary receptacles exposed to polluting matter, with an accumulation, perhaps to the extent of an inch or two, of sediment or rubbish at the bottom of them. It is in the dry season the trouble comes, and when the tanks fail recourse is had to an adjacent well, if there happens to be one, with water of doubtful purity, or even to the nearest waterhole with its many attendant evils, laying perhaps the foundation of disease or worse fatality.

The storage of water, therefore, commends itself to most people as an object of great importance. Dry seasons are of frequent occurrence, during which the labouring classes in the rural towns are deprived of a full supply, and have to resort to impure streams, or stagnant water, the quality of which is generally as bad as can be.

Many of the towns in Tasmania are so situated, especially where the rainfall is lightest, and the latter varies greatly in different parts of the colony.

Other towns are more fortunate, and in one case not only is there a large and permanent flow of water in the river, but wells sunk on several properties yield pure water of an unexceptional quality.

Upon this latter fortunate circumstance we need not dilate, unless it be to show how that self same water can be conveyed to every occupier in the town at a cheaper rate or much less cost than at present.

As Bailey Denton, M.I.C.E., writes:—"The supply of water to villages should not be dependent upon individual

action altogether, for the occupiers thmselves are powerless, and cottage-owners as a rule are not very liberally disposed in the provision of this necessary of life. There should be some public supply to render villagers independent of their landlords. Where there exist rivers, or streams of pure water near at hand, or where there is a subterranean water bed easily reached by sinking wells down to it it is needless to think of storage; but so long as there are numbers of small communities, with rating values so low as to negative the power to charge any large outlay upon them, it behoves us to consider (with the utmost care) any plan which will enable us to secure a sufficient supply of pure water at a cheap cost."

Is not the health and strength or, in other words, the sanitation of our rural labouring classes of as much importance as that of the labouring classes in the cities, and is it not a subject deserving more attention at the hands of the Central Government than we find to be the case? It is not until some dire disease has been making its ravages amongst the bone and sinew of the country that the authorities institute any enquiry into the cause of the evil. Then, probably, an official is despatched from a central board to inspect and report on the source of mischief, when, after some perfunctory suggestions are thrown out for future guidance, the subject is allowed to sink into obscurity again.

"Legislative powers are wanted which shall extend the proper distribution of water to the whole country." Prevention is better than cure, and something more than merely giving advice should be expected from the central authorities.

"It may flatter our local prejudices to leave the management of such matters in the hands of rural boards, but it will not be until some superior presiding authority takes the subject into consideration from a national standpoint that it will be effectually and economically treated. It seems, at first sight, to be the object of our Legislature to encourage wrong to be committed, then to point out the error, and finally to leave us without any power of rectification. It cannot be expected, while this course of action continues, any general scheme for improved and economical rural water supplies will receive attention."

Much good would be obtained and no hardship entailed by enforcing a law that landlords shall provide each dwelling with sufficient tanks to tide over the difficulties of a drought; or that, when several small dwellings are adjacent, a tank

should be constructed common to all, and holding, say, at the least three months' supply.

In many cases we find that not only is the drainage of the locality at fault, but that the water supply is in keeping with it. Disease is probably propagated quite as much by the consumption of impure water as by other unsanitary conditions. The former follows upon the latter in natural sequence. The once pure stream is surreptitiously converted into a drain owing to gross carelessness or want of thought. When heavy rains prevail, the decomposing matters on the surface are washed off and gravitate into the main water channel. In other cases they are carried and absorbed by sub-soakage into wells. There is abundant evidence of these facts. One of the finest streams of water in this colony, from which an important township, possessing a large public institution, derives its supply, is contaminated by the discharge of drains from farm yards, dwellings, and cesspits situated on its banks, and those at no very great distance above the intake.

In one town, comprising between sixty and seventy buildings, with over three hundred inhabitants, there are upwards of twenty wells, the whole of which have been condemned as containing impure drinking water. The rainfall is light, averaging about twenty inches per annum. The well-water can only be used for washing purposes, and even then the brackish nature of it is an objection. This is probably owing to the wells being sunk through recent marine beds, and it is not considered likely that any better results would be obtained in sinking deeper except at an unwarranted cost. The rain-water tanks being totally inadequate the distress in dry seasons is severely felt, and residents are put to much expense in carting water from a river; yet, in the face of this drawback, there are some people perverse enough to obstruct any action to obtain a better supply, though the average cost of such per head of the population is estimated to be considerably less than by the old-fashioned way of obtaining it. On the other hand, however, it is gratifying to note that local enterprise is being aroused by a few energetic individuals for obtaining a new supply by gravitation, advantage being taken of modern and economic methods of bringing the water by wrought iron piping into the town.

All water used for drinking purposes should be perfectly clear, bright, and without taste or smell. This is not always obtainable, and cases are rare where such natural conditions

can be found within a reasonable distance of a town. To arrive as near this perfection as possible, filtration must be resorted to. In a small community the extra cost of constructing filter-beds would be a serious item. People should, as a rule, possess a house-filter for purifying water used exclusively for drinking, but it is not every cottager who can afford even this simple luxury. Means might be devised with no great difficulty for supplying filtered water in separate tanks, placed in different parts of a township, so that those requiring it should make it their duty to obtain it. Ordinary iron tanks, erected on staging, might be so arranged, and internally fitted with frames holding the filtrating medium. The water could flow into one tank automatically by a self-acting ball-tap, and passing the filter rise by a syphoned pipe into an adjoining cistern, from whence it would be drawn off in the ordinary manner, or it could be drawn direct from the filter tank. Unless the case is exceptional, it would not be necessary to filter the whole of the water supply of a small country town. The mains, however, should be regularly scoured out at all convenient points where deposit is likely to settle and accumulate.

Where a supply fails in a township and expensive methods have to be resorted to in obtaining it, the water as a consequence is sparingly used when most needed, and moreover, being kept stagnant, is liable to become unwholesome. It is desirable therefore that some action should be taken by the central government, and liberal assistance offered to local bodies to place the small municipalities on a fair footing with larger and more wealthy towns.

During the year 1890 the Tasmanian Legislature passed an Act cited as "The Local Public Works Loan Act." This empowers the Governor in Council to grant loans for water supplies, among other objects, to any public body having the charge of such works. These works must be approved of by Parliament, and plans and specifications, together with an estimate of cost, are to be previously submitted to the Engineer-in-Chief for his report. Lately one or two municipalities have taken advantage of this Act and have bestirred themselves to obtain better and more permanent supplies of water for domestic and other uses; and now that a start has been made the difficulty of convincing others to entertain similar proposals will probably be less than heretofore. The Treasurer is authorised to issue any sums of money as required, under the aforesaid conditions, out of moneys raised by the

Governor in Council by the sale of debentures, at interest of five pounds per cent. per annum, chargeable upon the revenues of the public body until the original loan is liquidated.

To obtain this it is stipulated that 1 per cent. of the interest on the loan shall be set apart as a sinking fund until the Auditor-General shall certify that such loan has been completely liquidated. All moneys so set apart as a sinking fund acconnt are to be credited annually with interest at the rate of four per cent. per annum. Say, for instance, that a loan of £3000 is granted. The local public body must raise £150 per annum in rates to repay the interest at five per cent., and the Treasurer sets aside £30 of this money yearly, bearing compound interest at the rate of four per cent., to the credit of the sinking fund. Thus in forty-one years the original loan of £3000 is liquidated. In addition to the £150 raised to pay interest, it is of course necessary to strike a rate sufficient to cover both that and the cost of maintenance and supervision; but in a small community this would not amount to more than eight per cent. altogether on the capital outlay. It can safely be anticipated that the introduction of a good water supply would revive and encourage industry, causing an increase of residential population, and yearly raise the value of property, and consequently the rates.

Every town with a population not less than 300, and say fifty or sixty dwellings within half-a-mile radius, should be provided with a permanent water supply, unless exceptionally and badly situated; provided also that the supply can be obtained by gravitation within two or three miles, and that no large sums are paid for compensation. Public and private feelings are generally in sympathy with a good water supply, and, as a rule, property owners are found to lend their assistance rather than offer obstruction.

A consumption of thirty gallons of water per head per diem is a fair allowance for a rural town. For a population of 300 this would amount to 9000 gallons per day, or 3,287,250 gallons per year. We will allow, say, five millions of gallons to meet contingencies. Supposing, then, that a source of supply is obtainable direct from a stream or river having a rapid fall within two miles, and that circumstances are favourable for a gravitation scheme, allowing a head of water of fifty feet, a three-inch pipe would convey and discharge over fifteen millions of gallons per annum, or three times the above allowance. The cost of constructing such works,

including reticulation, to within fifty feet of any dwelling-house would not be likely to exceed £2000, judging from surveys and estimates already made in an average case. The interest on this amount at five per cent. being £100, and allowing for maintenance and supervision another £50, makes the annual cost £150, equal to an average charge of ten shillings per head per annum. This, on examination, will probably be found less than the average cost now incurred in those towns where water has to be carted, and then used in a sparing manner. The luxuries of having water for baths, irrigation of gardens, protection from fire, cleansing streets, flushing drains, and the general promotion of health and comfort, now denied, are possible in most cases, and may be obtained by a co-operation on the part of the residents, securing a supply covering all private wants and public necessities. It has been ascertained that the cost for a supply of water ranges from 30*s.* for cottages to £12 a year for large houses—or an average of £3—when, if a scheme were instituted as suggested, the cost would be lessened twenty-five per cent., and all the luxuries of an ample supply substituted.

The foregoing is only given as a supposititious case, and as being reasonably possible. Every town, and each case of water supply, must be dealt with on its merits, and according to circumstances.

To secure united action there should be some general obligations enforced by central authority. It is at present evident that as long as it is optional with rural communities to adopt or reject any proposals for sanitary reform or improved water supply, very little will be done. The subject is one which should not be lightly passed over by those who are interested, and it is desirable that every town board should take some initiative steps to ascertain whether the supply of water to the residents can be improved upon, obtaining for them increased advantages and a probable saving to their pockets.

In one or two cases, where a river flows through or near a town, pumping machinery has been resorted to. A turbine is erected in close proximity to a mill weir, and water is forced into tanks erected on staging at the principal cross roads. This, it is stated, gives every satisfaction. A rate of 8*d.* in the pound is struck to cover interest on outlay and for repairs, and is contributed by fifty or sxtiy residents. This is a commendable attempt in its way, but the cost of carting from the tanks must also be taken into account in ascertaining the total expense. It is not everyone who possesses a horse and cart,

so that the rate of eight-pence is no criterion of the actual charge on the consumer.

Many of the rural townships in Tasmania obtain their supply of water directly from the river flowing through or near them. In the majority of cases the water is pronounced good and wholesome. There are instances, however, where objections have been raised to a scheme for obtaining a permanent supply from such a source, owing to the water appearing turbid and discoloured during a heavy "freshet" or flood. In its normal state it is pronounceably clear, and to condemn it on account of the above fact is a hasty judgment.

A writer on this subject remarks, "Brooks and small streams are not desirable sources of water supply; the quantity of organic matter they contain in comparison with the quantity of flowing water in them is greater than that contained in the water of other sources such as rivers, springs, moorland tracts of ground, and deep wells." As to rivers, running water contains free oxygen absorbed from the atmosphere, and the more so where it has a quick motion over a rough bed, which causes its surface to be broken up, and exposes a greater number of particles of water to the atmosphere than where the motion is slower over a smoother bed.

It is a matter of common observation that the discoloration of rivers by the polluting matters poured into them from populous places gradually fades away, and that at some considerable number of miles below, if no other pollution takes place on the way, the water is clear, and in some cases quite fit to drink. The difficulty is to ascertain in what distance or in what time this effect take place, and there is nothing but supposition to go by in estimating at what distance from the polluting source water may safely be taken for domestic use lower down the river. It cannot very well be proved that they are wrong who advocate a river source for a supply of water even when it is well known that the water is contaminated higher up the stream.

The strongest argument in support of such a course is found in the want of proof that the water is injurious to the health of those who constantly drink it.

On the other hand, as to the disappearance of colour by long-continued flow, it is proved positively that water may be quite bright and yet contain matter in solution which disqualifies it for domestic use.

Another point worthy of passing notice is the utter

disregard shown by some surveyors to make provision for both water supply and drainage when engaged in laying out a new township. The excuse may be that they are "not instructed" to look into such matters, and their operations are confined to marking off a series of rectangular blocks, after the pattern of a chess-board. If this be so, then, surely the departmental heads under whom they are employed are open to censure. Every surveyor should, after fixing the boundaries of a new township, start a contour survey of the enclosed area, and eventually lay out the roadways so as to secure the best gradients for drainage. His next step should be to ascertain the most desirable position for a water reserve, which should be protected by the Government, and on no account alienated by either sale or selection. In the case of a newly formed township where houses are springing up "mushroom-like" from the soil, all the vital points of sanitation and water supply were utterly neglected. Such apathy on the part of the authorities is to be greatly deplored. It was not until fears were entertained of a serious outbreak of fever that any steps were taken to rectify the error. This town had a magnificent stream running through it, which, if wisdom and forethought had prevailed, should have been protected by a reserve on each side and otherwise dedicated to public purposes for health and recreation; in place of this it is crossed and recrossed by small allotments, partly built over, and speedily being converted into a public nuisance.

The following information on the existing state of water supplies to some of the rural towns is of interest. In many cases it is gratifying to notice that attention is being given to the importance of obtaining a better supply, whilst others express a cold-hearted satisfaction in letting things remain as they are:—

1. "We have no system of water supply, neither have we any intention to institute such. Residents obtain water from tanks and also cart it from wells. The charge for carting is eighteen-pence per load of 18 gallons. The present supply is not satisfactory, and it would be desirable to institute a better one as circumstances are favourable." Population, 300. Seaport.

2. "We have no system of water supply, neither have we any intention whatever to institute one. Residents obtain water from tanks and cart it from wells. The charge for carting is two shillings per load of eighteen gallons. The supply is not satisfactory nor good in quality. It would be

desirable to obtain a better supply, but circumstances are not favourable." Population, 1584. Important mining centre.

It must be remarked that there is something radically wrong here, where a community of nearly 1600 inhabitants are paying at times two shillings for eighteen gallons of water, and that not of good quality. To say circumstances are not favourable must infer that the town is exceptionally badly situated. The probability is no one has as yet undertaken the task of searching for an improvement. It is a case where a superior presiding body can step in with advantage and ascertain whether the continuance of this state of things is an unfortunate necessity.

3. "We have no system of water supply, neither have we any intention to institute such. Residents obtain water from tanks, and cart it from a dam when the tanks fail. The charge for carting is one shilling per load. The present supply is not satisfactory or good in quality. Circumstances are favourable for obtaining a new and better supply." Population, 465. Large mining centre.

4. "No regular system. Some residents have laid on pipes from springs, others obtain water from wells and tanks. The cost of carting is two shillings and sixpence per load of five casks, equal to about 150 gallons. The supply is not satisfactory, as the water is polluted. It would be desirable to institute a new and permanent one, the cost of which is estimated for one scheme £2000, and an alternative one £4000. An effort has twice been made to establish a town board to undertake the supply of water, but some of those who have a sufficient supply themselves object to pay a rate for the public benefit. Objections have also been raised that the supply of water would tend to increase disease. With a larger population the idea will doubtless be revived of a public supply." Population, 981. Agricultural centre and seaport.

5. "Water is obtained from the river, also usual rain-water tanks. A private individual pumps river water into a tank and charges sixpence per tun, from whence it has to be carted. A new system of supply is not warranted, but circumstances are favourable for instituting one if needed." Population, 520. Agricultural and pastoral centre.

6. "Water is obtained from the river and distributed in three public tanks at the principal cross-roads; force-pump and turbine being fixed near a mill dam. Water has to be carted from the tanks. A rate of eight-pence has been struck

to cover cost of outlay. Supply good and ample. It is further proposed to attach sevice-pipes to houses. The tanks are circular iron, holding about a thousand gallons, and erected on staging eight to ten feet in height. Supply-pipe with tap attached. There is a mutual understanding limiting the quantity of water taken, and the general arrangements are under the charge of the Inspector of Police. The township is small, and fifty or sixty residents contribute the water rate." Population, 281. Agricultural centre. (The public spirit displayed by the residents of this little country town in meeting their requirements of water supply is worthy of emulation by those who are equally well situated and boast a much larger population.)

7. "Water supply obtained from river and carted by those who require it. A private individual has erected a Pelton wheel and force-pump, and laid mains along the two principal streets. Residents who wish it can have a service-pipe attached to the mains at their own cost, the annual charge being thirty shillings per tap. It is not desirable to institute any further public supply at present, but circumstances are favourable for one." Population, 818. Agricultural centre.

8. "Residents obtain supplies from the river in addition to tanks, and there are abundant wells and springs. The cost of carting has to be taken into consideration. Circumstances are very favourable for instituting a public supply, but it is, perhaps, premature." Population, 895. Agricultural centre.

9. "Water is carted from river, costing one shilling per load. A few houses have tanks. The quality of the water is supposed to be good. It is very desirable to institute a new supply, as circumstances are favourable." Population, 540. Agricultural centre.

10. "Water is carted from river, and costs from one to two shillings per week. A new system is desirable, but means are not available." Population, 249. Agricultural centre. (This township is greatly resorted to by tourists and holiday seekers, and would no doubt rapidly rise in importance if a better system of water supply were obtained.)

11. "Water is conserved in tanks. There are a few wells in the township. Every summer water is scarce, and great inconvenience is felt. Circumstances are favourable for an economical supply. Methods have been suggested, but no action taken." Population, 426. Agricultural and pastoral centre.

12. "Water is carted from the river, the charge being one shilling and sixpence per load, and the mode of supply is very unsatisfactory. The Municipality has obtained, however, an Act of Parliament enabling them to institute a new and permanent supply." Population, 1084. Agricultural centre.

13. "Water obtained from river by a gravitation scheme. The supply is very good. The river is subject to pollution from farm drains and cesspits, which should be immediately abolished." Population, 1072. Agricultural centre and public institutions.

14. "Water is obtained from the river, the cost of carting being one shilling and sixpence per load. The method of supply is not satisfactory, and it is desirable to institute a new one, as circumstances are favourable. There are also private wells and tanks." Population, 517. Agricultural centre.

15. "Water is obtained from the river. The cost of carting is ninepence per cask. The present supply is considered satisfactory, but it is desirable to institute a new one on modern methods, as circumstances are favourable." Population, 387. Agricultural centre.

16. "Water is obtained from the river, the cost being one shilling to one shilling and sixpence per load. It is fairly satisfactory. Any new method of supply objected to on account of cost." Population, 536. Agricultural centre.

17. "Water is principally obtained from tanks; also carted from a creek at a cost of sixpence per hogshead. Is fairly good quality while the creek is running, but very bad when stagnant. In no district is there a more favourable natural supply of water, at a distance of some four or five miles, where a supply of the 'first water in the world' runs to waste, losing itself in the gravelly reaches of the rivulet, and utterly wasted. The cost, compared with the very great advantages to be derived from a continuous and abundant water supply, would be very small." Population, 282. Agricultural centre. (The probable drawback in this case is the distance of the proposed source of supply from the town, but it is worth investigation.)

18. "Water is obtained from a creek. There are also wells and tanks. The creek water is bad. It is desirable to institute a proper water supply. Circumstances are favourable, but thought costly." Population, 1129. Agricultural district and seaport.

19. "No system of supply and no proposal to institute one. Water is brought in buckets or carted from a 'race,'

There are also wells and usual tanks. The wells are liable to pollution from adjoining cesspits, and are looked upon as poisonous. The water in the race is good. It would be desirable to institute a proper system of water supply, but the nearest supply has been monopolised by a mining company, and the water is polluted." Population, 1420. Mining centre. (Some improvement is evidently needed here.)

The foregoing cases are only a few out of a large number that have come under observation. It would appear that there is an abundance of water to be had if people would only go the right way to work to procure it.

Where a water supply is deficient cleanliness cannot be maintained, and misery must surely be the result. We cannot all be rich, but we can all be clean.

Any technical details of how a supply of water should be brought into a town are omitted. Circumstances vary in nearly every instance, and no fixed rules can be laid down. The mode of raising water, either by mechanical aid or the natural power in the flowing stream itself, and its subsequent distribution, are matters left for the engineer.

It should be our common aim in life to assist each other in every practical manner, both for the good of ourselves and that of our neighbour, and the subject which has been treated in this paper is one in which there still remains a large scope for united action.

2.—BUILDING AND ARCHITECTURE: A DEFINITION AND VINDICATION.

By ALAN C. WALKER, A.R.I.B.A.

The annual deliberations of this valuable Association have already demonstrated their worth and justified their observance by the splendid opportunities which are thus offered to the scientific and artistic for inter-communication, and as affording an admirable means of translation to the average public of the best fruits of the long and weary study of those who are energetically devoting their lives to the development of mental culture. And it is my purpose, with your kind permission, while availing myself of such advantages, to briefly attempt a definition of Building and a partial vindication of Architecture.

In these modern times the necessity for such a definition

and vindication before the public is most essential in the colonies, for, if the cry that the art of architecture is totally misunderstood and ignored by modern communities in the old world has any justification, how very much more may we exclaim that the true art of architecture is a total stranger to our shores!

By this I do not mean to assert that we have no architects in the colonies, but I would have it understood that architecture as an *art* is totally unacknowledged by even a small section of any colonial community.

We have innumerable examples in which rich colonists have demanded and obtained gigantic buildings, ornate buildings, imposing buildings, and eccentric buildings, but we can hardly find a single instance in which it has been expected that beauty, majesty, suitability, or tasteful treatment should be the essential characteristics of any executed design. In other words, the public have expected a building that can appeal only to the most ignorant, and have invariably overlooked the possibility of the exercise of any art in the expression of it.

A layman's acquaintance with architecture is invariably obtained through the medium of a building. His immediate assumption is therefore that building is architecture. As a building is primarily for his use, and, if he so pleases, for his observation, he assumes that the profession of architecture is at best but another form of domestic catering. This unfortunate fallacy is so deeply seated that it would take much more energy than the earnest practitioner can possibly exert to eradicate it. That it is a fallacy is easily proved, for a caterer knows but little more than the technical methods necessary for the production of his wares.

While any architect upon receiving a commission from a client has perforce to be responsible for the convenience, suitability, stability, and exterior expression to the world of the design (you will notice I say design, not building) he is commissioned to evolve, and in this evolution he receives but scanty assistance from the client, who only approaches him in total ignorance, or at best hazy doubt, as to what form such a commision should take. A building proprietor invariably ignores his duty to the world. He does not recognise that the exterior of his dwelling is *not* his own property. He is not aware that it is the sole property of the surrounding community, and that it is in his power to inflict pleasure or pain, as the case may be, in the realisation of his requirements.

Many clients appeal to an architect, expecting by this means to obtain in the quickest and most economic manner a building of suitable magnitude. Such demands are simple and straightforward; they reduce the practice of an architect to a level very little above that of a commission agent, and by constant repetition overwhelm the architect and totally prevent the possibility of any artistic scope.

Such is understood as architecture in the colonies. In truth it is nothing better than building, and the architect but a superintending builder. Under these circumstances many may be excused if they join in the oft-repeated assertion that there is no art in architecture, and therefore there is some reason in the kindly contempt that the layman extends towards the colonial architect, who claims to practice an art.

As the layman ignores the possible existence of art in architecture he makes no demand for it, and consequently there is no encouragement for its supply. The most moderate study of Architecture will thoroughly convince anyone that the practice of it must be essentially of a highly artistic nature, and that it is a full sister art to Music and Painting. These words, so oft repeated, are only half understood by the intelligent public, and until their value is wholly acknowledged, architecture must necessarily be precluded from exercising that ennobling influence which marks the most valued characteristics of a fine art.

The impassioned utterances of Ruskin, published in England at a time when architecture was masquerading in the worst form of plagiarism and deceit—when the best endeavours towards freedom and truth of any individual architectural genius aroused strong opposition, and were awarded with the public opprobrium—have undoubtedly laid a most valuable foundation, upon which will be effected the best means of architectural redemption; and I feel confident of support and approval when I claim for the bulk of Ruskin's architectural writings a very great importance, and, while not being a Ruskinite, I even go further and claim for them an essential position as containing the ethics of the art.

His influence upon the craftsmanship of architecture has been infinitesimally small, but his writings must always remain invaluable monuments of ethical teaching to all true students of architectural art in its highest development; and even the leading architects of his time, after constantly decrying the value (to the profession) of all his architectural

writings, have acknowledged the firm conviction that the world would be sorry to lose what he has thereupon written.

His writings have greatly caused in the past, and will even by as much more in the future, lead the student or layman to more properly estimate the true position of the art of architecture, will stimulate him to deeper thought, and even impress upon the architect the seriousness and responsibility of his life's work, and increase his enthusiasm.

His failure to effect any technical influence upon the art is manifestly explicable after a careful perusal of his published notes, which show a total absence of any logical formulation or concurrent sequence; hence his teachings are open to repeated attacks, encouraged by his frequent contradictions of himself; and to such extremes has he permitted his beautiful rhetoric to carry him, that he has perforce to state that "Half he ever wrote he would be glad to destroy;" but, notwithstanding this, the strongest and best of his teachings are so evidently valuable, while his weaker conclusions of themselves fail to gain any dangerous support, except from the unthinking and sentimental.

In considering matters artistically architectural, it has been so frequently asked (when the layman has most deservedly been accused of complete ignorance) by what means can persons beyond the professional pale obtain the requisite means of making honest and valued criticisms?

Now, every moderately educated person of the present day has almost of necessity to read in some part the more valued literature of his own time, and but a few paragraphs of the "Seven Lamps" or the "Stones of Venice" would stimulate and assist the thoughtful layman to something like a just appreciation of architectural art, and encourage him to exercise but a small amount of common sense in formulating his opinions of any design newly realised.

It is one of those truisms most universally known and almost as universally ignored, that building at its best is but the expression of an architectural design, and that it is in no wise any form of architecture itself. If building were architecture, it would be essentially necessary for the artist in architecture *i.e.*, the architect, to work upon it with his own hands. Such a necessity has never even occurred to to anyone, and without debating this point further I think we may safely assume that it is non-existent.

On the other hand, building can thrive and continue without the most distant association with anything architectural

or artistic, and thus has it thriven most lustily in the colonies, where we have so many examples of large and sometimes convenient buildings dressed out by the builder with various applied ornaments culled from some architectural authority. These strictures most particularly apply to the most populous class of buildings—those for domestic purposes—where the construction of by far the greater majority is entirely entrusted to men almost totally devoid of even moderately good taste.

The practice of architecture cannot, in any form, be attempted until the science of building is thoroughly mastered; this science includes a thorough knowledge of the proper combination of various materials so effected as to cause convenience, while so calculated as to remain for an indefinite period *in statu quo* and impervious to the local action of the various natural forces.

In fine building is the practice of the science of statics, and a knowledge of it is essential to the proper evolution of design in architecture; and thus in the inception of design this is the only relation that exists between building and architecture.

As to architecture itself, I feel that I cannot do better than condense the definitions of it we have received from Ruskin and Viollet-le-duc. In the first of the "Lamps of Architecture," that of "Sacrifice," Architecture is defined as "The Art which so disposes and adorns the edifices raised by man for whatever uses, that the sight of them contributes to his mental health, power, and pleasure;" while Viollet-le-duc, in his incomparable lectures, describes it as "Something more than the art of collecting and combining materials in a substantial and convenient form, and, as the sister of music and poetry, bound to give a wide scope to imagination, to inspiration, to taste, and bound to subordinate even the material laws involved to that divine afflatus which breathes upon the musician and the poet." To these two men, who, of all modern writers, I may safely affirm knew best the subject on which they wrote, architecture ranks with the highest and finest of arts. The very practice of it is ennobling and, if earnestly attempted, highly laborious,—success is only obtained after much study and exclusive attention,—and in its highest forms must make great demands upon the moral rectitude and probity of the artist.

The architect in his work suffers from a great disadvantage in having to appeal to the builder before it is possible to effect

a translation of his conception to the public. A musician, with the aid of a few strings of catgut, and the painter with the assistance of a piece of canvas and a few pigments, can at once place the public in possession of their finest conceptions. The architect has to call in the aid of skilled artisans, of much expensive material, and requires that previously a demand be made for the erection of some edifice before he can display to the world the results of so much sacrifice and exertion. In fine, we may with justice consider that a good and beautiful building is the outward and visible sign of the inward and spiritual grace of the art of architecture. If thus viewed, and as it were the individuality of the art properly acknowledged by the world in general, we would have no such controversies in which it was eagerly debated whether architecture was an art or a profession. Architectural design must ever be an art, and the realisation of it to the public nothing better than the profession of building supervision.

The hazy notion of the connection between the two is typically exemplified in the descriptions of newly-erected public buildings which from time to time appear in the daily press. In these it is of interest to note that no proper architectural description is attempted, but a rambling statement emphasising the importance of the work most generally, pointing out the additional conveniences obtained, and, while generally ignoring the name of the architect, gives the names of the builders and leading artisans in the final paragraphs, thus crediting them with the design as well as praising them for the construction and workmanship. This may be taken as a typical example of so-called architectural criticism by laymen, and serves as the most valuable illustration of the esteem in which architecture is held by the majority. On the other hand, any criticism of a musical recital or art exhibition receives the most careful attention of an experienced writer well acquainted with his subject; for every paper of even moderate pretentions finds it necessary to secure the permanent services of an artist or musician for the sole purposes of criticism, while any matters architectural are generally left to the tender mercies of a junior reporter.

If it is the architect's duty to give to the world the best of his art, and to work to that end only, it is equally the duty of the world to, in some part, make acknowledgment of it, and prove itself capable of proper discrimination.

In general it has been the acknowledged habit for the

layman to carefully avoid any form of architectural observation or artistic criticism. He is generally content to observe of a building that it is large, surprising, crowded with ornament, or common-place; and he invariably shirks anything like the exercise of reasonable intelligence when called upon to express an opinion.

So much has been said by laymen concerning the various edifices that from time to time spring up in our larger cities, and upon all such occasions such remarks have been so ready, and so evidently bear the stamp of thoughtlessness, that they at once suggest the idea of having been made with carelessness and contempt, as if such a subject (to their minds) were utterly divorced from anything artistic.

To criticise any reasonably good example of an art, all will admit that much thought, care, and common sense must be expended. In music we frequently redemand a number (if disposed to praise) before expressing an opinion. In viewing a good painting we stand long before it, examine it in various lights, and return to it again and again before we dare to express the effect it produces upon us. In neither case do we offer the artist so deep an insult, or to such an extent forget our own self-respect, as to deliver an unconsidered judgment. But in architecture it is not infrequent to base our opinion upon the thoughtless remark of a friend, and frequently to adopt the first expressed judgment that may occur to us.

That this should be so is all the more surprising, because all that is requisite for a fairly correct criticism of the architectural value of a building is the exercise of but very little common sense and the observance of but few methods of reasoning.

On the other hand, amateurs can only acquire a sound taste, which in architecture especially is identical with sound reasoning, by contact with artists, and it is here that the architect can do so much to form the tastes and guide the understanding of the amateur, by permitting himself no latitude in the direction of unexplained effect or treatment of questionable taste; for it is one of the most important duties of the architect to urge clear views and sound reasonings in explanation of every part of his design, and thus check the varying whims and fancies of the irresponsible observer.

Now, with but very slight assistance the architectural layman can constitute himself a reliable critic by the observance of the following common-sense rules. Firstly, let him examine

the building with the idea of detecting false treatment of material, and he can do nothing but good if he vehemently condemns, for instance, the effects produced by the coating of an iron girder with cement in imitation of a continuous stone; the superficial imitation of one material by a cheaper substitute; any form of constructive untruth; the painting or coloring to imitate valuable materials or excessive labour. Secondly, the exterior elevation should in some part explain the interior accommodation; failing this the architectural treatment must necessarily be weak. Thirdly, those parts that have of necessity to carry greater weight must by their mass indicate power. Fourthly, the design as a whole must indicate some differential ratio from base to finial, and be capable of some expressive translation to the most casual observer. Fifthly, he must admit that the building is composed primarily of various floor spaces superimposed upon one another, supported by wall veils pierced to effect entrance, light, and ventilation,—the whole having some logical association with the essential purpose for which the building was originally intended. And finally, let him constantly repeat to himself Pugin's antithesis, which states that architecture consists in the ornamentation of construction, not the construction of ornament.

By these methods only can we acquire anything like good taste; for, as a French writer on architecture says, "What we call taste is but an involuntary process of reasoning whose steps elude our observation."

Acquiring taste is nothing else than familiarizing ourselves with the good and the beautiful, and is in no wise associated with what we may be pleased to respect as of historical or archæological value.

It has ever been the merit of ancient architecture to be almost exclusively the true reflex of ancient manners, customs, and requirements; and it is because of this that we are so strongly disposed to respect all edifices of former centuries, even if their architectural value be somewhat obscured by barbaric effect. It therefore behoves us to carefully separate what is of historical and what is of architectural value among the edifices that remain to us in the old world. And it is as essential that we should exercise the principles of criticism I have just explained in observing ancient as well as modern examples; for we can never find any reasonable justification for joining in hysterical admiration of ancient examples because they are ancient. The beauties of classic or mediæval Gothic

are only existent when considered in relation to the era of their construction, and it is only what they teach us of beauty in the abstract that we are entitled to use in modern design; and therefore if we require a building to serve the purpose of a public library, it is not architecture to reproduce in *facsimile* a Grecian temple, while the reproduction of a feudal castle has no justification when utilised as a modern suburban residence. Let us remember to only admire buildings because they are beautiful, and not because they are stained with the crimes of the good old days. And so if the public in their demands and criticisms, and the architects in their designs, hold tenaciously to freedom of thought and action, and make such thought and action expressive of nothing but logical truth and honest self-sufficiency, we can look forward with hopeful expectancy to a period of architectural magnificence somewhat in accordance with the promising prosperity of our colonial communities.

A great step in the right direction has been exemplified in some modern examples of American work, and Australian architects must necessarily feel what vast possibilities still remain for newer and better development in their work when they look at what has been accomplished by a few earnest designers who have followed the right path in the various centres of American population. As an exemplification I feel justified, in conclusion, in paying some slight tribute to the memory of the powerful genius of the late H. H. Richardson, who has given to America an architecture purely its own, and who has thus, by the most powerful of methods —the force of good example—shown to modern society the possibility of infinite development, which could in the future produce an architecture suitable to all the complex requirements of modern times, while at the same time elevating all by its majesty, beauty, and truth.

Let us hope that architecture, to fulfil its destiny, will in the near future be the favourite study of our greatest artists, whose labours will be richly rewarded, and whose responsibilities will be successfully discharged to a highly appreciative community.

3.—RAILWAY EXTENSION AND BREAK OF GAUGE.

By ALLAN STEWART.

The subject of this short paper may very properly be considered of much public and national interest at the present time, in view of the necessity existing for opening up the interior and sea-board of the various Australian colonies for general and strategic purposes, in an effectual way, and at the lowest possible cost. The subject has been under the consideration lately of the Tasmanian Parliament, which during last session passed an Act empowering a syndicate to construct an extension of the north-western system of railways to the great mineral centres of Zeehan and Dundas on a reduced gauge, and in Victoria the matter is now before Parliament, and the Standing Committee on railways there and that Government is asking for information on the subject in reference to the extension of the Gippsland system of railways; whilst no doubt other colonies have the same thing in view for the mountainous portions of their vast territories.

All authorities on railway matters, both engineering and traffic, are quite alive to the disadvantages of any break of gauge on main trunk or trans-continental railways where heavy traffic has to be handled, or where speed is an important object; but it has become a serious question in countries which are in the early stages of development whether the opening up of the country, rich in land, minerals, timber, and scenery cannot be obtained by simpler and less expensive railways, and whether by a judicious treatment of the subject this and the next generation may, while thus realising all their requirements, leave a rich legacy to those who follow, who would have ample means and much more reason and necessity to return to the standard gauge.

The natural features of the country to be traversed should in each case determine the gauge of the railway projected, and in this way no doubt the standard gauge of the various main lines in these colonies, which vary so much, have been arrived at.

I shall instance the Tasmanian main line with its gauge of 3 feet 6 inches, and corresponding curves of five chains radius, by the application of which a comparatively cheap line has been constructed to carry a heavy traffic; and the same rule applies throughout the Tasmanian railway system. To have adopted curves of even six chains radius, the cost in

many cases would have been doubled, and curves of seven or eight chains radius would have brought up the cost of Tasmanian railways to equal the most expensive railway in the world.

To apply the same principle in the opposite direction, and so still further to reduce the cost of railways, is the object of this paper.

In flat country or reasonably flat country it would be unwise to depart from the standard gauge, or even in country where the sidling or sloping ground is regular, and where gullies and spurs are absent, there would still not be sufficient cause for constructing feeders or branch lines on a narrower gauge. Light lines in such cases would effect the object desired ; but in country characterised by steep mountain spurs and gullies such as Tasmania, Gippsland in Victoria, and the hill portions of the other colonies, the question of the gauge becomes the all-important one in the consideration of railway extension.

The author of this paper has within the last few years laid out three railways in Tasmania, and two in the hill country of Victoria, four of which, including the Victorian lines, could be constructed on a narrow gauge at a materially reduced cost ; and these four lines, involving the expenditure of enormous sums, if constructed on the standard gauge, may be considered as representing the character of the greater portions of all future extensions in Tasmania, portions of Gippsland, and probably the mountainous portions of all the other colonies. The author of this paper was called upon lately by the Hon. the Minister of Railways in this colony to report upon the comparative cost of the standard and narrow gauge in respect of one of the railways named, viz., the proposed Mole Creek-Zeehan Railway, which, although traversing as difficult country as any in Tasmania or the other colonies, and rising at the summit to 3300 feet high, can be constructed to the standard gauge at a cost certainly not greater than some of the lines already constructed ; but when the narrow gauge principle is applied, the estimated cost is so vastly reduced that other colonial governments may well pause to consider, and follow the enlightened example of Tasmania in regard to future railway extension in hill country. The preparation of the parts being much more in the engineer's line than the preparation of papers for scientific societies, I will venture to read the Report named as giving a fairly approximate estimate of a

line constructed on the Tasmanian standard gauge and on the proposed narrow gauge in very difficult country. The Report is included in Parliamentary Paper No. 162, Session 1891, and is as follows:—

MOLE CREEK-ZEEHAN PROPOSED RAILWAY.
2 feet 6 inch Gauge.

Hobart, 20*th October*, 1891.

SIR,

HAVING received instructions on the morning of the 16th inst. to prepare a Report on the saving in construction which would be effected by a change of ruling grade from 1 in 40 to 1 in 33, and of ruling curves from 5-chain radius to 2½-chain radius, I have prepared a contour plan of a portion of the line as laid out from 14 miles to 17 miles along the eastern slope of the River Mersey, which probably contains the largest quantity of earth-work in the same distance of any other portion of the line; also, a section of the same showing in black the line as laid out, the ruling curves being 5-chain radius, and in red the section along the red line on plan, the ruling curves being 2½-chain, which, together with the following remarks, I have now the honor to submit.

Location of Line.—The line for the first 2½ miles is along flat easy ground, for the next 37 miles along sloping ground, for the next 5 miles along flat button-grass plains, for the next 30 miles along sloping ground, for the next 5 miles round Lake Rolleston comparatively flat ground, and for the remaining distance to Zeehan about 21 miles along sloping ground. I mention this, because on the point as to whether the ground is sloping or flat depends the question of comparative cost; and, so far as the question of curves is concerned, any saving depends on whether mountain spurs and gullies form the ground features.

I estimate that 60 miles of the line will be along broken sidling ground, that 28 miles will be along fairly even sidling ground, and that 12 miles will be on flat easy ground.

The length, therefore, upon which the greatest saving would be effected by the adoption of 2½-chain curves would be 60 miles. A much less saving would be effected on 28 miles, and none at all on 12 miles, excepting what will be due to the narrow gauge.

Comparative Quantities.—The following statement of quantities on 1½ miles from 14 miles to 15½ miles, which is as heavy as any other part of the line will be, shows the saving due to 2½-chain curves over 5-chain curves:—

	Cub. Yds.
Cuttings on line as laid out (5-chain radius).........	82·305
Ditto on red line (2½-chain radius)..................	18·900
Saving on 1½ miles	63·405

	Cub. Yds.
Embankment on line as laid out (5-chain radius)...	89·106
Ditto on red line ($2\frac{1}{2}$ chains)	22·500
Saving on $1\frac{1}{2}$ miles	06·606
Concrete culverts on line as laid out, lineal yards...	289·
Ditto on red line...	187·
Saving on $1\frac{1}{2}$ miles	102·

Thus in the main items of construction, by the adoption of the narrow gauge a saving would result in first cost of excavation per mile, 42·270 cubic yards; embankments per mile, 44·404 cubic yards; culverts per mile, 68 lineal yards.

A saving would also be effected throughout the whole length of the line in ballast and other minor details, and, exclusive of permanent way, it may be estimated that the narrow gauge could be constructed for about one-third ($\frac{1}{3}$) of the cost of the standard gauge.

In the one and a half miles quoted there would be nine curves of $2\frac{1}{2}$-chain radius, the longest being 5 chains, with several curves of 3-chain radius, in lieu of the curves laid out having radii of 5 chains.

Gradients.—With regard to the proposed alteration from the standard gradient of 1 in 40 to 1 in 33, this would only favourably affect several small cuttings and embankments on the flat ground, and the cuttings on the various summits, which in all cases are light, and I therefore do not see any advantage to be obtained in making any alteration in this respect, but great disadvantage in the working of the line, and very great disadvantage when in the future it is found necessary to resume the standard gauge. I would therefore suggest, in the event of the narrow gauge being determined upon, that the line as laid out be made the base for laying out the narrow gauge line, and that the levels and gradients for the broad gauge line be maintained, so that in those places where the line as laid out will apply to the narrow gauge lines (and this will extend over many miles) the work already done will be an important contribution towards the construction of the standard gauge line.

Another very important consideration in the matter of levels is the great advantages which would accrue towards the construction of the substituted standard gauge in the delivery of materials all along the line at the levels desired. In broken country such as is represented on the accompanying plan and section, the $2\frac{1}{2}$-chain curves appear to suit the spurs and gullies, and thus the narrow gauge line will throughout be almost a surface line, therefore in many places the cuttings and embankments, and even culverts,

would not be applicable to the standard gauge line when constructed; nevertheless, an existing narrow gauge line at the same level as the proposed standard gauge line would reduce enormously the cost of its construction.

Another very important consideration in the comparative merits of the two gauges is, that the narrow gauge might be constructed in a third of the time which would be required for the construction of the standard gauge.

Whilst in the present undeveloped state of the Western mineral fields the advisability of constructing the standard line of the colony might be matter of grave doubt, a narrow gauge line, constructed for 30 per cent. of the cost, and within 30 per cent. of the time of the former, even although traversing many miles of non-producing country, will no doubt in a few years make a handsome return to the promoters by the development of existing and new mineral fields, of which there is at present great expectations, and also would develop the existing cattle traffic and open the large tract of grazing land lying between the Forth and Mersey, and create a market for the prolific agricultural district of which Deloraine is the centre, and, further, open up scenery of the finest description, hitherto unknown to tourists and others.

I have, &c.

The Engineer-in-Chief. ALLAN STEWART.

MOLE CREEK-ZEEHAN PROPOSED RAILWAY.

Narrow Gauge.

Hobart, October 20th, 1891.

SIR,

I HAVE the honor to supplement my previous report on a portion of the line from 14 miles to 15½, by stating that, having gone into the next mile and a half in the same manner, I find that it will be affected even more favourably, not only as regards cuttings and embankments and culverts, but a tunnel 154 yards long on the line as set out will be entirely avoided by the substitution of 2½-chain curves for 5-chain curves.

I have, &c.

The Engineer-in-Chief. ALLAN STEWART.

It may be deemed desirable here to emphasize two or three of the points in the Report just read, viz., that in laying out all projected narrow gauge railways, the setting out of the line (which indeed in every case is the most important part of the engineer's work) should in the first instance be laid out, as at present, for the standard gauge railway, from which

contour lines every ten feet in height would be constructed, and the surface grade line laid down from these contours, upon which data the best possible narrow gauge line would be determined.

This system of contours is illustrated, and the general effects seen on the plans and section which accompanied my Report, and which the Engineer-in-Chief in Tasmania has been good enough to lend for the purposes of this paper, and which are now at hand ready to be explained if any gentleman so desires.

By this system you have the survey for all time of a standard gauge railway, and the necessary data for laying down the narrow gauge line, at little more than the expense of one survey; and it would be difficult country indeed where curves of $2\frac{1}{2}$ or 3 chains radius would not follow at the engineer's pleasure the surface grade line, or at least entail only very shallow cuttings and enbankments, and do away with tunnels, long culverts, and heavy viaducts.

The other points to be emphasized are the great saving in cost and time in constructing the lines. Let us take, for instance, three of the lines lately in course of being surveyed in Tasmania, viz., the Derwent Valley extension to Zeehan, the extension from Mole Creek to Zeehan, and the Waratah-Zeehan Railway, altogether about 280 miles. These, on the standard gauge, would cost the country say £1,680,000, and if done simultaneously would take at least six years to complete, whilst on the narrow gauge the cost to the country would be reduced to about £680,000, and if done simultaneously the time would be reduced to about two years; so that there is a million of money to spare for another 400 miles of railway to still further open up the country, and the interests of the nation would be advanced by four years. In this period of economy there is no economy more required than in railway extension in countries where traffic is an unknown quantity, and which yet must be opened up; and if railways are constructed on a narrow gauge at small cost which will carry all the possible traffic for the next 20 years or more, why should we spend the enormous amount required for a standard gauge line, which will carry no more traffic, because there is no more to be carried? The one would very probably yield some return, the other *most* probably would have difficulty in paying its way.

The immense reduction in the first cost, of time in construction, and the resulting more speedy opening up of the

country, may be said to exhaust the advantages of a break of gauge, yet these are of sufficient importance to far outweigh the disadvantages accruing, and which, summed up, amounts to a somewhat reduced rate of speed, some delay in the delivery of goods and mineral traffic, and to a somewhat increased cost in transhipment—fatal, no doubt, in countries already largely developed—but as regards speed in such a country as Tasmania, the travelling public have necessarily been already educated up to a very moderate rate, which they may be assured can never be much increased; while as regards delays to goods traffic consequent upon transhipment and the expense attending it, I think the utmost has not been done towards removing these difficulties. I have given some little thought to this subject lately, and whilst having some delicacy in even hinting a theory, because in all railway matters no theory without experiment is of much value, it may just be said that it has reference to the accommodation of the gauges on the frame of the trucks, the transhipment to be done entirely by the locomotive, which would be effected by a very slight increase to the ordinary labour at stations or junctions.

Where traffic is light, and speed not a very important matter, the main objection to a break in gauge sinks into insignificance when the question practically is narrow gauge at small cost or no railway extension at all; and where there is no progress there must necessarily be decay.

4.—THE BENEFITS DERIVED FROM, AND METHOD OF CARRYING OUT DETAIL SURVEYS OF CITIES AND TOWNS.

By D. M. MAITLAND, *President of the Institution of Surveyors, New South Wales.*

(Plan.)

By the term City Detail Survey is understood a survey made in the most careful manner possible, fixing on one comprehensive scheme the existing positions of all buildings, walls, fences, kerbings, survey marks, natural features, &c. that are within the area to be surveyed. Its primary use is in connection with, and anticipatory of engineering works for sewerage and water supply systems, but it also enables the registration of land titles to be simplified and perfected. It is of the greatest possible use for municipal taxation purposes, and is invaluable in various engineering works besides those

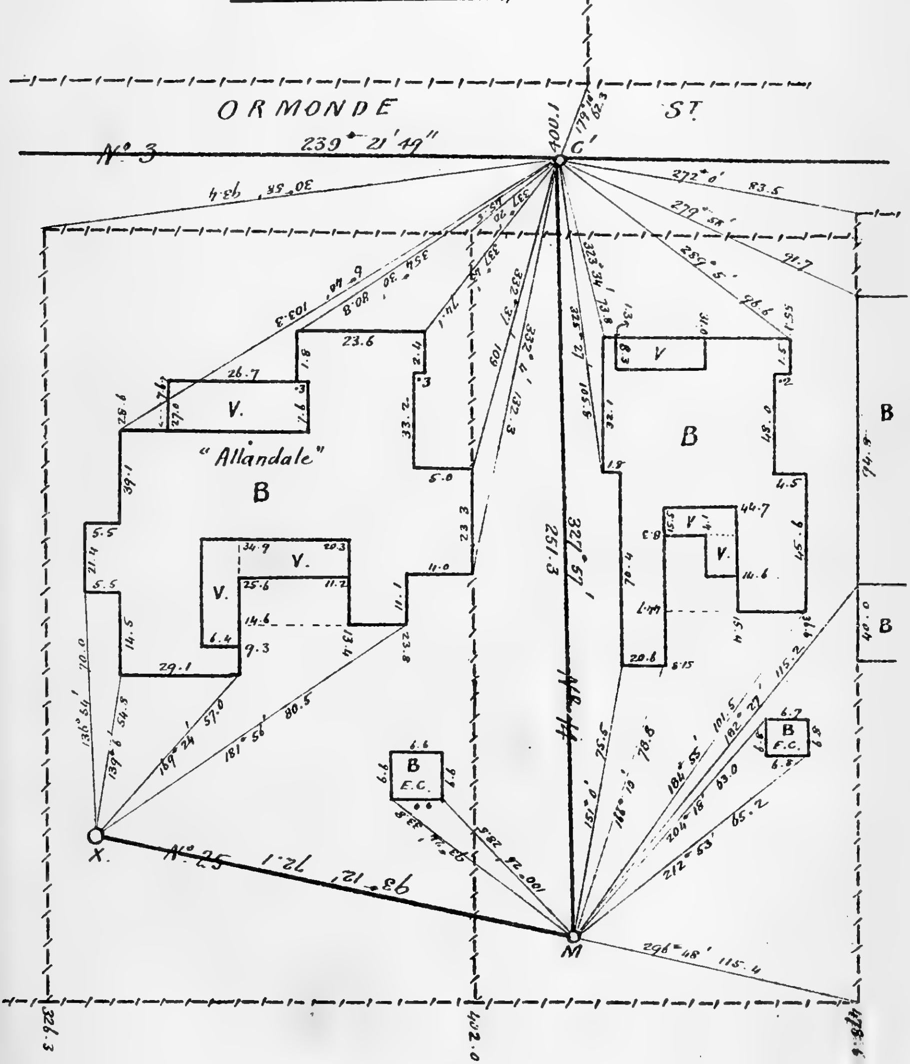
above mentioned. In fact I hope to be able to show that the advantages derivable from it are so considerable that it may be looked upon as indispensable for all cities and large towns of the present day.

Taking, first, its connection with sewerage and water supply works. After the general principles of a scheme are decided on it is necesssary to know the position of all features both natural and artificial before the details can be prepared and worked out; the trend of the ground, areas of the different watersheds, position of natural watercourses, &c. must be ascertained to a nicety. The actual areas occupied and the character and extent of the occupation must be known, as well as the material of all buildings, together with their *exact* position, not only for the most convenient placing of the main and subsidiary sewers, but also subsequently for the reticulation. For laying down the main drains and water mains the lines of streets and lanes with the kerbing and buildings immediately abutting thereon must be accurately fixed, as well as the interior details in any sections where tunnels might with advantage be cut through instead of following the road. If carried out in a systematic and comprehensive manner the whole of the details can be fixed at what is comparatively a small cost in addition to that necessary for laying down the main works. When the detail survey is carried out on one system of coördinates and the levels are taken in connection with it, the whole of the data are ready to the hand of the engineer for carrying out his part of the work.

All land situated within cities and towns is more or less of a valuable character, and as it is essential that surveys of such land be carried out in a scientific and accurate manner, it is obvious that it would be an immense advantage if the Department upon which the duties of dealing with the registration of titles and land transfers devolve were in possession of really accurate plans and records. The detail survey supplies the exact position of all holdings, surveyed to the one meridian, measured with the same unit of length, and all referable to the same origin of coördinates, with but a trifling expansion of the work which is necessary for the primary object of the survey. As very nearly all the work necessary to render a survey for sewerage available for land registration and transfers is confined to computing and plotting, the extra cost is by no means excessive, and would be saved over and over again in the avoidance of disputes and litigation as to positions of boundaries, &c., the detail

Specimen page of Field notes

Detail Survey



survey placing every portion on an absolute and unchallengable basis.

Innumerable arguments might be adduced in support of the contention that in order to deal satisfactorily with real estate accurate surveys are necessary, but it is, I think, such a self-evident fact that I will content myself with reminding those present that the Bar Committee of the House of Commons, after exhaustively investigating the whole subject of registration of land titles, reported to Parliament in 1886 that it was absolutely necessary to have an accurate survey made as a basis for all land transfers. This necessity is supplied by the detail survey in a more perfect manner than any number of solitary or isolated measurements, however carefully carried out.

Every holding or tenement being accurately fixed and plans prepared showing the extent of the holding, together with the materials, &c. of the improvements erected thereon, the duties of municipal assessors would be much lightened, rates could be levied in a more satisfactory manner and at a lower cost to the councils, resulting in a material saving of money of the ratepayers; in fact the detail survey fulfils most completely all the requirements of a cadastral survey.

In addition to the above advantages derivable under all circumstances from a detail survey, there is another which may be considered a contingent one, that is, it is equally available for carrying out any other engineering works than sewerage and water supply: for instance, if a city railway were required the whole of the information necessary for deciding on the best route is to hand in the most convenient possible form.

I think I have said enough to indicate that detail surveys of towns are almost indispensable; but as it is a class of work that may easily be carried out in an extravagant, nay wasteful manner, it is essential that it be well designed and properly conducted, so as to ensure the maximum of efficiency at a minimum of cost; economy in this as in almost every other work is best preserved by skilful and systematic management.

A detail survey, in common with every other survey of at all a comprehensive character, can only be conducted with entire satisfaction both as regards accuracy, rapidity, and consequently at a comparatively low cost, if based upon a trigonometrical survey. In addition to the ordinary observing stations of the trigonometrical survey, the positions of various clearly defined points, such as finials, church steeples, angles

of buildings and permanently marked points on the ground, are determined by intersecting observations from the triangulation; these intersections, being chosen in convenient positions over the whole area to be surveyed, afford means for maintaining azimuth and reducing the whole survey to the same unit of length as that of the trigonometrical survey.

The values of all the points of the triangulation, both observing stations and intersections, are carefully computed to one common origin or zero, and the value of each station subsequently fixed in the detail survey being connected with the trigonometrical survey is also computed to the same origin; consequently as the coördinates of every single detail or survey mark, angle of building or other prominent landmark are referable to one zero, the bearing and distance between any two points of the survey, however far apart, can be readily computed in but a line or two of figures.

In order to ensure against the accumulation of instrumental or chainage errors which might result from one surveyor's work joining on to anothers without their being confined to a certain limit of error, it is necessary to run a carefully carried out standard or base line survey on which the detail survey proper is dependent. This is generally conducted by the supervising surveyor, as on the care and accuracy of this particular part of the work the correctness of the whole survey chiefly depends.

The standard survey is run as a sort of network over the whole area to be detailed, and is connected wherever possible with the points already fixed by the trigonometrical survey. The lines should be, as far as possible, along main streets, the stations being fixed at crossings or other points convenient for starting fresh traverses from. The surrounds should enclose areas that can be conveniently divided into from three to six sheets or blocks of survey, as it is quite unnecessary to run the standard traverse along every street.

In the instrumental work a six-inch transit theodolite should be used, both verniers being read, and the angles repeated not less than four times, angles being also taken to one or more prominent landmarks, such as church steeples, in order that each station may have a reference bearing from it. The azimuth adopted throughout must, of course, be identical with that of the triangulation. A convenient and rapid way of reading the angles is to carefully set the theodolite to the back bearing of the last line, then read the bearings from left to right of each of the lines required, leaving the instrument

clamped to the bearing of the last or *right* hand line observed; then unclamping the lower plate, the telescope should be directed towards the first station and another round taken, in the manner indicated in the following example :—

At Station G.

Trav. 8.		St. Jude's spire.				Trav. 25.				Trav. 9.		
° ′ ″		° ′ ″	′ ″	′ ″		° ′ ″	′ ″	′ ″		° ′ ″	′ ″	′ ″
24 24 50	—	57 30 00 —	30 20	(30 10)	—	89 9 50 —	10 10	(10 00)	—	259 18 45 —	19 5	(18 55)
259 18 55	—	292 24 15 —	24 15	(24 15)	—	324 3 50 —	4 10	(4 00)	—	134 12 50 —	13 10	(13 00)
134 13 00	—	167 18 00 —	18 20	(18 10)	—	198 57 50 —	58 20	(58 5)	—	9 7 00 —	7 00	(7 00)
9 7 00	—	42 12 10 —	12 30	(12 20)	—	73 52 10 —	52 30	(52 20)	—	244 1 10 —	1 20	(1 15)
		33 5 20				64 45 10				234 54 5		
		„ 5 20				„ 45 5				„ 54 5		
		„ 5 10				„ 45 5				„ 54 0		
		„ 5 20				„ 45 20				„ 54 15		
		57 30 ·07				89 10 00				259 18 56		

Ordinary poles or ranging rods should not be used for observing on account of their size and the difficulty of keeping them exactly perpendicular; in lieu of them what are technically known as tripods are most convenient. These consist of a fine metal bar swinging in an upright position on gimbals at the top of a very light tripod stand, and kept truly vertical above any point by a plummet suspended from its lower end; for long sights a carefully turned piece of wood can be slipped on to the top of the bar.

The measurement of the traverse line of the standard survey must be conducted with great care. I should recommend the use of a 66 feet Chesterman's steel band, $\frac{1}{4}$ inch wide and divided to tenths of links. In order to ascertain the length of the band used, a standard should be laid down in some convenient locality; but its actual length when used for chainage as regards its relation to the trigonometrical standard is best ascertained by measuring and remeasuring between two stations of the triangulation, the coördinates of which are of course known. The actual length of the steel band itself cannot well be altered, but as the expansion of a 66 feet steel band is ·01 inch for every 2° Fahrenheit, it is easy to compute at what temperature it is of true standard length. Different ingenious contrivances have been devised, such as adjustable handles, &c. for altering the length of the band itself, but I am not in favour of their use. The band being almost invariably suspended in the air when measurements are being made, the temperature can be easily taken and noted from time to time as the survey proceeds, the corrections for length being afterwards applied in the office. When there is any slope the measurements should always go down hill, so that the hind chainman holds *to* the mark, never plumbing over it. The tape is kept horizontal and free from vibration by a long grooved level supporting it in the centre. The leading end is attached by means of a spring balance to a sliding ring on an upright movable pole, kept in position by a plate at the bottom end on which the chainman's foot is placed; one tension, generally 10 lbs., is always kept up when chaining. A rather heavy but very accurately centred plummet is suspended by a fine line running through a small ring at the end of the band so arranged that it can be raised and lowered as required. The leading chainman places the straining pole in line as directed by the hind chainman; he then slips the brass ring to the correct height on it as indicated by the man with the level at the centre, and the surveyor places a small metal plate under

the point of the plummet, the plate being kept in position by a couple of small nails. The man at the lead then pulls slightly on the pole so as to get the exact tension, gently raises and depresses the plummet so that its point *just* touches the metal plate, when the surveyor marks the exact position with a sharp pencil.

Although in the description the *modus operandi* appears rather complex it is not so in reality, and the measurements can be carried out with fair rapidity, 160 chains per diem being frequently done, with an average error not exceeding ·25 link per mile. The main stations of the standard survey should be carefully placed in a certain relation to the building line or side of the street traversed, the traverse line being parallel with and at a fixed distance from one side of it. Some surveyors advocate the exact centre of the street as the best position for these standard or base line traverses, but on account of the vehicular traffic I am of opinion that it would be an inconvenient position, and consider that about two feet outside the kerb on one side, so that the traverse line clears the awning and verandah posts, is about the best place. When the stations are placed a few measurements should be taken from them to three or four angles of permanent buildings in the immediate vicinity, so that if destroyed they could be replaced. The stations can be defined in various ways, sunken stones with metal plugs inserted, heavy iron bolts driven firmly in, lengths of gas pipe set in cement, &c. but whatever marking is adopted it should be made as permanent as possible. A good plan is to have the station mark protected in the same way as the ordinary gas and water plugs are, and they should be placed in charge of the municipal councils. Stations so fixed and the traverse lines connecting them form not only the basis of the detail survey, but also permanently mark the alignment of the streets, and so define the frontage boundaries of the properties abutting thereon. The field work having been completed the traverses have to be computed and adjusted to the values of the triangulation by the distribution of any errors, which, however, should be very small. A skeleton plan is afterwards prepared giving the full particulars of the survey.

For the detail itself the whole area to be surveyed is divided into blocks, bounded preferentially by streets or natural features, each block not exceeding 28 chains by 17 chains, which is the maximum size that can be drawn on the paper used, on a scale of 60 links to an inch. A tracing, showing

the boundaries of the block, the traverse lines of the standard survey adjacent, and sketches of the main stations to be connected to with reference to bearings, &c., is forwarded with the instructions for measurement to the detail surveyor. When speaking of the standard survey I mentioned that the surrounds should enclose from three to six sheets or blocks, the reason of that is that it is generally advisable to employ one detail surveyor on all the blocks within a complete surround of the standard work, in order that his work may be closed harmoniously on it.

The best plan is for the detail surveyor to go over the block first, sketch in every detail, and choose the positions for his stations before he commences his instrumental or chainage work. He then starts from one of the main stations and traverses through the whole of the blocks he has on hand, fixing the position of every detail by actual bearing and distance, ordinary off-setting not being permissible. The principal judgment required is in choosing his interior stations in order that the work may be carried out with no greater number of stations than is necessary; along the streets his traverses should form base lines with the same relation to the building lines or alignment as those of the main standard survey. The method of angling for the traverse lines in the detail survey is similar to that recommended for the standard survey, except that generally but two repeats are necessary instead of four or more. The bearings of radiations to the details are read direct from the instrument by the ordinary back angle method, repeats being unnecessary, as the bearing of the starting line is always rechecked. The lengths of the sides of all buildings are also measured, so that the three sides of every triangle being taken any error in the length or bearing of a radiation is discovered when the plan is plotted. The chainage of the traverse lines is conducted in a similar manner to that described for the standard survey, but with not quite so much care, and therefore with greater rapidity.

This class of survey is so different to the ordinary routine of country work in any of the colonies that, when initiating it, it is advisable to start with, at any rate, one or two experienced men to train the junior surveyors, and the experience so gained will soon enable them to decide upon the best method of carrying out the work with the minimum expenditure of labour.

The field notes should be all kept in ink in the field, and

must exactly indicate every operation performed, no erasures being permitted under any circumstances, but if an erroneous entry is made the pen should be drawn through it and the correct figures entered above. Special care should be taken with the field notes, both in their preparation and subsequently, as they are the actual official records of the field operations of the survey, being of far greater importance than the plan afterwards prepared from them. On completion of the field work the detail surveyor computes his traverses, &c., applying any necessary corrections to the latitudes and departures to make the coördinates of his various survey points agree absolutely with those already laid down by the standard survey. The original field notes, together with a tabulated form showing his traverse lines, computations, amount of corrections, &c., together with a sketch showing the position of the co-ördinate lines and a rough plot of his traverses with references to the pages of his field book.

Draftsmen specially trained to that class of work should be employed on the preparation of the plans, which should be plotted on the best drawing paper, Antiquarian size, double mounted, that is, two sheets of paper mounted with holland between them. As rolling strains the paper and nearly always injures the correctness of the plotting, detail plans should be always kept flat. The scale generally used, 60 links to an inch, is found to be suitable, because the lithographs or zincographs prepared are exactly equal to 40 feet to an inch, which is a convenient size for laying out engineering works, and is sufficiently large for the minutest detail to be shown. Coördinate squares of ten inches each are carefully laid down, each coördinate line being a multiple of six chains from the origin, and the traverses are plotted on the coördinate system, the protraction being only used for plotting in the radiations. By this method all accumulation of errors in drawing is avoided, and as the square on the paper indicates the unit of length used in the plotting of all within that square, any changes in the paper caused by temperature or hygrometric conditions do not affect the correctness of the plan. No colour should be used on the plans except for ruling in the traverse lines and radiations, the materials of which the buildings are made being indicated by small letters, B. for brick, S. for stone, &c. All the requisite measurements having been taken on the ground it only requires comparatively a few computations to be made to place on the plan the dimensions of all holdings within the block, with their relation to the base line along

the street, thus making it a record of all the different private properties throughout the area covered by the survey.

Upon completion of the plans, or even sooner if necessary, the usual levelling is carried out; but as this is conducted in the ordinary way it calls for no special attention. Carefully prepared tracings on cloth should be made of those portions of the finished plans which are intended for publication, particular attention being paid to the firmness and equality of the lines on the tracings, as photo-lithographic reproductions are made of them to the same scale.

From the description of the operations of the survey generally, especially the chainage, it might appear that as a whole a complete detail survey is extremely costly; but the time occupied over the chainage of the traverses by the detail surveyor bears a very small relation to the rest of the work, not more than about one-fifteenth of the whole, consequently the apparent elaboration in that part of it has little effect upon the total expense. Less care in that particular part of the survey would very materially affect its usefulness as a whole, and would not cause any saving worthy of consideration. It must not be forgotten that when once a survey of this kind is completed the main work of it is done for all time; for, although occasional revisions are necessary on account of alterations in buildings and new erections in order that the plans may be kept up to date, this can be done without occupying much time, especially as it is possible to fix most new buildings with perfect accuracy by cross measurements from those whose positions were definitely determined by the original survey.

I believe that all engineers who have had any practical experience with sewerage systems agree that an accurate survey showing all buildings, &c. is necessary. What an advantage, then, would it be to have the work conducted in a thoroughly systematic manner, so that the employing body, whether the Crown or Borough Council, might with true economy incur the comparatively small extra expense required to render such survey absolutely perfect for all the purposes I have striven to describe in the few notes I have just read. Certainly it would in future minimise the work in towns for surveyors, except when subdivisions were required, but, carrying out the doctrine of the greatest good to the greatest number, the public would reap the benefit to the fullest extent. Even in cities where detail surveys have already been carried out, they could be made fully available

for records in connection with the registered titles to land by slight extensions of what has been done, with certain necessary modifications of the method I have recommended, which could be adapted to meet the special circumstances, and the public would soon be repaid for the extra expense by the increased simplicity and consequent reduction in costs in connection with land transfers.

5.—NOTES ON HYDRAULIC LIME AND MORTAR-MAKING.

By A. O. SACHSE, C.E., M.E., M.S.E. Lon., &c.

In dilating upon this subject I am fully aware of the magnitude of the task, and I am also alive to the fact that included among those who may hear or peruse the following notes may be men of extended professional experience, and to whom, in all probability, many of my jottings may be already familiar ; but at the same time there are probably many persons to whom the contents of these pages may appear novel, and prove both interesting and instructive.

It is seldom (if at all) that the experience of any one man can embrace the particulars that are known to many individuals, and acting under this feeling I have freely quoted from several essays of recognised authorities, whose opinions and experiences on the matters under consideration coincide with my own.

A careful examination of portions of the different essays which I have collected from will show a marked agreement in important particulars.

Seeing that the manufacture of mortar, rubble, &c. is so intimately connected with and dependent upon the quality of the lime used therefor, I have felt it necessary to make a few remarks under this particular heading.

Hydraulic lime of good quality can now be obtained cheaply in Victoria, and its superiority over other limes should commend its use for building purposes.

The following report on some of this lime was furnished by me a few years back :—

" I have carefully tested the samples of hydraulic lime forwarded to me, and have much pleasure in being able to report favourably thereon. I have subjected the lime (after its having been compounded with sand) to several tests for

hydraulicity, with results which I consider highly satisfactory, the lime proving itself of great value for use in damp situations, as well as for general mortar-making purposes."

In comparing the analysis of the lime in question with that of other well-known and approved hydraulic limes, I find the following :—

Analysis of Victorian Limestone by Mr. J. Cosmo Newbery, C.M.G., &c., Government Analyst.

Carbonate of lime	55·02
„ magnesia	41·37
„ iron	1·42
Silica	·10
Soluble salts	1·94
Moisture	·15
	100·00

No. 1. Bolsover, Derbyshire,
„ 2. Middleton, Yorkshire,
„ 3. Roach Abbey, „
„ 4. Park Nook, „

Analysed by Professors Daniell and Wheatstone for the Special Commissioners appointed to Report for the Building of the Houses of Parliament, London.

	1	2	3	4
Carbonate of lime	51·5	54·19	57·5	55·7
„ magnesia	40·2	41·37	39·4	41·6
Iron and alumina	1·8	0·70	0·3	0·4
Silica	3·6	2·53	0·8	—
Water and loss	3·3	1·61	1·6	2·3

The Commissioners mentioned selected these four varieties, and the results have shown that their choice was a judicious one. The similarity of the Victorian limestone to these varieties is very marked.

The distinction between the mortars made of *pure* and those made of *impure* carbonates of lime consists in this, that the former have no property which can produce setting without the presence of carbonic acid; that is, practically, without exposure to the air. Mortars made from impure carbonates, on the other hand, contain within themselves to a greater

or lesser degree this property of solidifying without the assistance of the atmosphere. From this property, which enables them to harden under water, they are called hydraulic limes, or hydraulic cements.

As pure lime mortar must combine with carbonic acid that it may harden or set, and as in this combination it must part with the water contained in it, it follows that hydrate of pure lime in a state of paste, if kept moist, will remain for an indefinite period without absorption of carbonic acid and consequently unfit for use as a cement, whilst if exposed to the dry air without pressure, a small quantity of carbonic acid gas is gradually absorbed from the atmosphere; but the lime assumes the form of powdered chalk or marble, which is wholly useless as a cement, no longer forming paste with water.

Hydraulic lime is now being most extensively used in America, and is generally recommended by professional men in that country for its superior and uniform properties and reliability. In a very interesting paper entitled "High Class Mortars," read at a meeting of the Engineers' Club at Philadelphia, the writer spoke particularly of the growing demand for high-class mortars, and said :—"When immense buildings of eight, ten, and twelve stories high are run up in a single season the demand for better mortar is making itself felt.

In the olden times, when buildings like the Strasbourg Cathedral took centuries to build, the defective qualities of ordinary lime mortar were not so noticeable, as the weight was super-imposed gradually, and allowed the mortar time to harden." This is no longer the case, and the ordinary lime mortar inside the thick walls, nearly deprived of air, sets slower than the mortar on the outside where the air reaches, and as the weight is piled on a settling takes place in the wall where the mortar is still soft. This is due to the fact that ordinary lime mortar sets mainly through the aid of an external element, viz., carbonic acid gas, which it takes up from the atmosphere slowly. Deprive it of air, and the setting never takes place. To meet this emergency experienced architects and engineers are looking to mortar having hydraulic properties or in other words cement, not only for use in damp foundations but for use in entire brick and stonework of large buildings where speedy work is desired.

Cement (*i.e.*, hydraulic lime) mortar differs from ordinary lime (in its setting) in that it sets within itself without the aid of external elements. The great rule in mixing mortars

is to see that the lime and sand are thoroughly and intimately amalgamated.

Mortar, when made with ordinary lime, is at its best a mechanical mixture, and the difficulty of thoroughly mixing wet lime and sand together is known to all builders.

Cement mortar (hydraulic lime and sand) on the other hand can be thoroughly mixed in a dry state, and forms, by the addition of water, a *chemical mixture*, containing within itself, as already stated, all the elements for its own hardening. This hardening takes place throughout the whole mass simultaneously. It sets not only on the outside when the hydrosilicates of lime, alumina, and iron is additionally strengthened by the carbonic acid gas there absorbed by the lime from the atmosphere, but it hardens likewise in the interior where the setting, caused by the formation of the hydrosilicates, goes on indefinitely, improved, however, in all cases by moisture.

The simultaneous hardening of the cement mortar thus enables the builder (without waiting for it to dry out like lime mortar) to pile upon it immense weights, as there is present no free water to ooze out and cause a settling or sliding, the true cement in setting refusing all water not chemically combined.

It is evident, then, that for all buildings having any pretensions to importance, it is advisable to use mortar made from hydraulic lime. The well-known American "Rosendale" Cement is a *natural* cement, and is about equivalent in analysis and hydraulic properties to the Victorian stone.

Natural cement is made by burning in an ordinary draw kiln hydraulic limestone or cement rock at a moderate heat, and grinding the calcined product to fine powder.

Mr. F. W. Rudler, F.G.S. in his essay on dolomite, speaks thus of the stone:—"This mineral is essentially a double carbonate of lime and magnesia, containing in the normal varieties carbonate of lime 54·35; carbonate of magnesia 45·65; a percentage composition corresponding to the formula $CaO.CO^2 - Mg.\ O.CO^2$ ($Ca.Mg.2CO^3$). The relative proportion of the two carbonates is, however, subject to considerable variation, the species passing on the one hand into carbonate of magnesia.

The presence of protoxide of iron replacing the isomorphous oxides lime and magnesia often causes the mineral to assume a brown colour on exposure to the atmosphere, when such varieties are distinguished as brown spar."

The origin of dolomite has long been a standing enigma to the geologist; but as the question is one of only theoretical interest, its discussion would be out of place in this paper.

The dolomites of Durham are employed in the chemical works on the Tyne for the manufacture of sulphate of magnesia (Epsom salts), and is greatly used for the manufacture of carbonate of magnesia.

Mr. Rudler says that if this stone is properly calcined it will furnish an excellent hydraulic lime, and quotes M. H. St. Claire Deville, who has called attention to the powerful hydraulic properties of caustic magnesia by its union with water to form a definite hydrate, and Mr. Rudler also mentions that if the stone is calcined below a red heat, the carbonate of magnesia suffers decomposition, whilst the carbonate of lime remains almost intact; on slaking this calcined dolomite the magnesia combines with water, and this hydrate cements the unaltered particles of carbonate of lime.

Mr. Vicat, a well known writer on the properties of limes, classifies them somewhat as follows:—

"Fat, or common lime, which gains no consistency under water, remaining in a state of paste in water unchanged, but dissolving wholly in pure water frequently changed.

"Poor lime, which is a combination of lime and sand, the lime in which exhibits the same phenomena as if no sand were present, slightly hydraulic limes obtained from limestone containing 8 to 12 per cent. of other substances such as silica, magnesia, iron, &c.; these set in about 20 days after immersion, but in a year have not gained a consistency greater than hard soap. They dissolve in pure water, but very slowly.

"Hydraulic limes from limestone containing from 12 to 20 per cent. of the above-mentioned ingredients; these set in from six to eight days, and in six months acquire the hardness of soft stone.

"Extra hydraulic limes from limestones containing 20 to 30 per cent. of the same ingredients; they set in from two to four days, and have attained great hardness in a single month. In six months they resemble the hard calcareous stones which bear cutting."

With regard to the manipulation of limes in making mortar it seems to matter little whether pure lime is slaked in large or small quantities at once; but with hydraulic limes only so much should be slaked out at a time as can be worked off within the next eight or ten days.

In order to make sure that the lime has entirely lost its affinity for water before being laid as mortar in the joints of a building, it is safe to leave the hydraulic limes for from twenty-four to forty-eight hours after slaking before mixing them into mortar. For want of this precaution mortars have been known to expand and to burst even the heaviest masonry.

Twelve to twenty-four hours is long enough for pure or feebly hydraulic limes; they should be left covered up during that time. Hydraulic limes should be used as fresh as possible from the kiln, and as they slake with difficulty they should be ground first to ensure the operation being done perfectly. Brunnell makes the following important observations regarding the calcination and slaking of different limestones:—"Those which are obtained from the stones containing much silica swell in setting, and are likely to dislocate the masonry executed with them. On the contrary, those in which alumina is in excess are likely to shrink and crack. The magnesian limestones or dolomite appear to be the least exposed to these inconveniences, and to retain without alteration their original bulk."

The quantity of water required to be thrown on the lime varies with the density and purity of the lime and its freshness, but generally speaking it will be between $\frac{1}{3}$ and $\frac{1}{2}$ the bulk of the lime. With pure and freshly burned lime more water is evaporated by the heat produced than with a stale, or with a hydraulic lime.

The heat generated by Victorian hydraulic lime during the (so-called) process of slaking is hardly perceptible, only the slightest warmth being noticeable, whilst with some of the ordinary limes in use the heat given off by the lime when water has been thrown upon it is sufficient to set fire to any woodwork or bagging in close contact to the lime; indeed many serious conflagrations have been traced to this source. One instance which came under my notice was that of a stable which had been set on fire through someone having carelessly thrown some pieces of newly burned ordinary limestone among the wet straw on the stable floor. In point of fact, ordinary limestone when burnt and unslaked, if carelessly stored, may be considered as dangerous as a parcel of lucifer matches when unprotected from rats. This is not the case with cements or burnt hydraulic limes, for the reason that little or no heat is generated by moisture coming in contact therewith.

Sand is generally mixed with lime, however, for the sake of both economy and strength, and for ordinary purposes any good lime will stand the admixture without its properties being seriously impaired. It remains to be considered how much sand may be thus safely used, and what kinds of sand are the best.

Theoretically the best wall is that in which the cementing material is just as strong as the brick or stone cemented. There is evidently no object in having the cement stronger; but up to the point of equal resistance the strength of the whole wall will vary with that of the cement. One writer on this subject says:—"In the case of fat lime the strongest mortar that can be made with it bears such a very small proportion to the strength of a brick, that it matters comparatively little what proportion of sand is used with it. If there is much saving effected in price, three of sand may be used to one of lime, and the resistance of the mortar formed would only descend to $\frac{1}{20}$ of that of the brick. But (as has been said before) such a mortar should never be used at all. With feebly hydraulic limes $2\frac{1}{2}$ cubic feet of sand may be mixed with one cubic foot of lime, and the result will be a mortar of $\frac{1}{6}$ or $\frac{1}{7}$ the resistance of brick. With hydraulic lime of good quality $1\frac{1}{2}$ to two parts of sand may be used to one part of lime, but this is the limit. For hydraulic works and foundations equal portions of lime and sand should be the limit allowed."

Opinions differ considerably as to what sand is best suited for mixing with lime. Vicat concluded that the advantage of the three different descriptions of sand employed by him varied with the nature of the lime.

He calls coarse sand those whose grains, supposing them round, vary from $\frac{1}{17}$ to $\frac{1}{8}$ of an inch in diameter; fine sand, where the grains vary from $\frac{1}{25}$ to $\frac{1}{17}$ of an inch in diameter; and according to this statement ranked their superiority with limes as follows:—

	1st.	2nd.	3rd.
For eminently hydraulic limes......	Fine	Mixed	Coarse.
For slightly " "	Mixed	Fine	Coarse.
For fat limes " "	Coarse	Mixed	Fine.

Powder, especially when derived from calcareous substances, will be found to make excellent mortar both with hydraulic and eminently hydraulic lime. He considered that the greatest difference in the hardness of mortars of fat limes,

which the use of this or that kind of sand is capable of occasioning, rarely amounts to more than $\frac{1}{5}$, but it exceeds $\frac{1}{3}$ with the mortars made from hydraulic or eminently hydraulic lime. That is, if the maximum hardness in the two cases be 100 the minimum will not be far from 80 in the first case and 60 in the second.

The general opinion has been that pit sand is better than river sand. It is usually rougher and more angular, and whether rightly or not, it is certain that these qualities are valued by most practical builders.

Sea sand has been condemned by many as the worst that can be used. Smeaton in building the Eddystone lighthouse found mortar made with salt water just as good, if not better than that made from fresh; so that in his case we may suppose sea sand impregnated with salt would have made equally good mortar as fresh-water sand.

Davy, in his "Treatise on Foundations," remarks, "It is almost unnecessary to observe that washed sea sand will produce precisely the same effects as the best river sand." Now it is probable that the difference of opinion on this subject may arise from the different kinds of lime that have been used. Fat lime will not harden if kept damp, and the presence of salt in the mortar will always tend to keep it so. Hydraulic limes, on the other hand, harden all the better, though not so quickly, from being kept damp, and it is therefore reasonable to suppose that in their case sea sand is not prejudicial. For internal plastering sea sand is evidently unfit, on account of the moisture which keeps exuding from it, disfiguring its appearances, and making the room damp and unwholesome. Builders, however, seem agreed that sand should be *clean*. This is a most important point, and one by no means sufficiently attended to. Good mortar can never be made where the sand is filled with earthy and loamy particles, and the fact of these particles being argillaceous adds nothing to their advantage, as uncalcined argil does not possess any properties of value in mortar making. Treussart recommends that sand should be washed in masonry basins from 7 to 10 feet wide, from 12 to 16 feet long, and about $2\frac{1}{2}$ feet deep, laid about a foot thick, water let over the sand, and well stirred up, allowing time for the sand again to sink to the bottom; the water should be suddenly let off by a sluice at the one end, and the operation should be repeated till the water passes off but slightly turbid, when the sand may be considered clean.

From the conflicting opinions on the subject of sand, we may conclude that in making ordinary mortar our present knowledge and experience would not justify any great expense in order to procure sand of any particular colour or grain, or from any particular source, but that generally sand either too coarse or too fine should be avoided. That for ordinary buildings we should, if possible, use river or pit sand in preference to sea sand; but if any great saving is effected in using the latter we should not hesitate to do so, taking the precaution to wash it carefully first. That for hydraulic buildings and general foundation works, sea sand is just as good as any other when making mortar with hydraulic lime. That in all cases it is worth while to take pains to clean the sand before using it or to make sure that it is clean—*i.e.*, free from earthy particles.

In applying mortars the first great point to be attended to is the necessity of thoroughly wetting the materials to be joined. If the moisture is suddenly drawn off any hydraulic mortar it will not harden. Dry bricks and most stones absorb a large proportion of water, so that if mortar is applied to the dry surface of a brick and another pressed on it the whole of the moisture will be squeezed out of the mortar and taken up by the bricks, and the mortar itself will crumble into powder; whereas if the brick is thoroughly wetted it will be able to absorb no more moisture, and the mortar will set as it ought. With many compact stones it will be sufficient to water the surface at the moment of using them, but porous materials, such as sandstones and bricks, especially of the ordinary plastic make, should be allowed to soak in water for some time before use. All professional men and even most ordinary bricklayers know these particulars full well; but strange as it may seem to state, a great proportion of them are unaccountably careless in this respect, and feel quite satisfied when having seen a few bucketsful of water dashed over a heap of bricks, whilst presumably the bricks in the interior of the heap have hardly been even damped on their exterior.

The next requisite in applying hydraulic mortar is that the mortar should be as stiff as it can be used without inconvenience, and without the risk of all the unevennesses of the joints remaining unfilled when the bricks or stones are forced home. The third requisite is to prevent rapid drying of the mortar after it has been applied.

Mortar is sometimes applied in a form termed "grouting,"

that is, mixed with an excess of water and poured liquid into the joints of the masonry. Good grouting can be made of hydraulic lime and fine sand mixed with water and poured immediately into the joints; it hardens quickly without shrinking, and solidifies all its water.

Personally I am not much in favour of the practice of grouting unless under exceptional circumstances, and I think the system is not generally approved of by engineers. Scott thus remarks of it:—" If the joints of a work are not properly flushed up, undoubtedly grouting is of great advantage, especially when dry bricks are employed in work, but the strength of grout cannot at all compare with that of a good stiff mortar; for grout, when the water dries out, is merely very porous mortar, and the more fluid the grout the weaker the work will be."

Much difference of opinion exists as to whether the mortar joints of masonry should be thick or thin. In modern practice in some masonry and all brickwork, where strength is required rather than ornament, thick beds and joints of good mortar will be useful. Thin bricks or tiles will also be better than thick bricks, as the material will be better burned and consequently more enduring; more good mortar can also be used, which in such work gives strength. With the introduction now going on of improved compressing machinery and of the Hoffman and other reliable burning kilns, improperly made and insufficiently burned bricks are, I am glad to say, likely to become things of the past, and it is interesting to note the great superiority in the quality of the bricks now being made and sold about Melbourne over those of some years back.

Cresy in his work "Civil Engineering" strongly deprecates the use of rich fat limes for any building purposes, and recommends the use of hydraulic lime when mixed with sand as an excellent mortar for buildings that are out of water as well as for those in water, and points out the economy of this particular lime.

Hydraulic mortars may be used safely and with advantage in thick beds, and joints in masonry for docks, for railway bridges, viaducts, and retaining walls; as also for warehouses, goods stations, mills, tall chimneys, fence walls and all similar structures; reservoir walls, tank walls, and covering arches for water tanks ought most certainly to have thick beds of good hydraulic mortar. A good deal of course depends on the quality of the mortar, for if it be a slow-setting one

allowance must be made for the gradual settlement of the building; especially must this be considered in arch work.

The success attending a lengthened trial of mortar made from some Victorian lime has been very marked; it was used in building a weir in this colony some years back, which, after standing the strain of several floods, is still intact; indeed, so strong have the joints become that when a little while back some alterations were being made, the sprawls of stone had to be broken in some cases before the mortar allowed them to be removed. The builder was so pleased with the results of his trial of the lime that he has decided to use it in the construction of another weir. This gentleman writes as follows regarding his weir:—"It is built with mortar made from Victorian hydraulic lime, no 'cement' whatever being used, and its resistance to water is so effective that when the water does not cascade over it the bed-rock on the lower side is as dry as a bone. So convinced am I of its superior hydraulic character that I am now using it in the construction of another weir lower down on the same creek."

Professor Rankine, in his treatise on "Civil Engineering," tabulates the results of experiments as follows:—

A year and a half after mixture—

	Crushing force in lbs. on the square inch.
Ordinary lime mortar	580
Hydraulic lime mortar	680
Ordinary lime mortar beaten	800
Hydraulic lime mortar beaten	930

Sixteen years after mixture the increase of strength is in the following proportions—

For common mortar	$\frac{1}{8}$
For hydraulic mortar	$\frac{1}{4}$

One year after mixture—

	Tenacity in lbs. on the square inch.
Good hydraulic lime	170
Ordinary hydraulic lime from	140
Ordinary hydraulic lime to	100
Rich lime	40
Good hydraulic mortar	140
Ordinary hydraulic mortar	85
Good common mortar	50
Bad common mortar	20

For concrete making the poor or hydraulic limes are best adapted. In England the blue lias varieties are much used.

It is necessary here to explain the advantage which arises in treating the lime before it is mixed with the gravel or stones. Beton differs from concrete in its being subject to two operations. First, the hydraulic lime or cement is mixed with sand and treated as a mortar, to which afterwards is added the required quantity of aggregates. Concrete, however, as originally prepared in England, only consists of one clumsy operation of mixing the matrix and aggregate together. Hence it is presumably more correct to say that beton is essentially a French process, and concrete the somewhat analogous one in England. In both cases the mixture is accomplished with the same object, although with a difference of detail. There can be no question that the beton process is the more perfect one, and especially when the concrete is made into blocks or frames, offers great advantages over the other.

When however, it is used as in engineering works in large masses or trenches, it involves a double operation; first, the preparation of the mortar, which is followed by its incorporation with the larger ingredients, such as gravel, broken bricks, or stone. When moulding the concrete the mortar can be used simultaneously with the gravel, and under such circumstances with beneficial effect. Its use in this way secures a solid mass, having a minimum of interstitial space. In all concretes it is necessary to adjust the proportions of the hydraulic lime, sand, and gravel so that no vacuities will occur in the mixture. The larger the size of the aggregate the more necessary it is that attention should be paid to this point. With an aggregate of an average size of say two inches it will be found that in every cubic yard there will be vacuities equal to about 11 cubic feet, so that the mortar should be equal in quantity to the interstitial space. This vacant space will, of course, vary with the size or particles of the aggregate, and the amount of shrinkage will also fluctuate accordingly. When in a dry state it will shrink less than when wet in proportion to its specific gravity. A silicious or quartzose sand has a specific gravity of 2·6, and a solid cubic foot of it would therefore weigh about $162\frac{1}{2}$ lbs.—a cubic foot of water weighing 1000 ozs. Sand of this kind, without being specially dried, when filled into a measure of a cubic foot, however, weighs only 75 lbs., showing that the space between the grains was nearly equal to their own bulk. The weight of sand of the above

specific gravity may serve as a good guide or standard in estimating the amount of mortar that should be mixed with gravel for concrete; for the difference between the weight of a cubic foot of the aggregate when pressed together and $162\frac{1}{2}$ lbs. will indicate the space to be filled. The difference should be as accurately ascertained as possible, although it is safer to have an overplus than too little of the necessary hydraulic cementing material.

One writer on the subject of "Foundations" remarks, "The nature of concrete that should be used for foundations depends on the nature of the soil it is to be laid in, the object being in all cases to get as nearly as possible a homogeneous bed under the structure. If the soil is wet, or the building is of great weight or special character, the concrete should be made of hydraulic lime and sand and broken stones, in about the same proportions as would be used in rubble masonry, that is to say, the lime should be about $\frac{1}{7}$, the sand about $\frac{2}{7}$, and the broken stones about $\frac{4}{7}$." These, however, must be considered only as average proportions. For medium hydraulic lime and ordinary wet soils the proportion of lime must be varied inversely as its quality is better or worse, or as the circumstances are more or less important. In such circumstances the concrete, if properly constituted and laid, may be considered as a solid coherent mass, capable of bearing without crushing the weight to the square foot mentioned in recognised tables as the crushing resistance of different kinds of concrete, a proper co-efficient of safety being used. The bed of concrete must also be thick enough not to break by transverse strain, but so as to settle in one mass if the subsoil yields. These two considerations will determine the area of the bed for the foundation.

Considerable misapprehension exists as to the desirability of keeping ground lime for any length of time before being used. The amount of injury which lime in a finely powdered condition receives from exposure arises from its avidity for moisture. If, therefore, the air is excluded from it, and the situation in which it is kept is dry, no injurious effect of any extent will arise. Smeaton found this, for he used Aberthaw lime with great success in important engineering works after it had been kept in casks for seven years.

The use of Thiel lime in the construction of the works in the Suez Canal is also confirmatory of the possibility of using lime after it has been some time reduced to powder. The precaution, however, must be insisted on of keeping it only

in perfectly dry places, and as far as possible excluding the air from it.

Since writing the above I have been informed upon good authority that excellent hydraulic limestone and also "true cement" rocks are obtainable at no very great distance from Hobart. If this be so, wisdom would seem to dictate that builders and others interested in the subject should make every effort to work the deposit. There is a large demand in all the southern colonies for cement, and if the operations be judiciously and economically managed the project should prove pecuniarily successful.

6.—ON THE EVIDENCE FOR THE PREVALENCE OF THE CIRCULAR FORM OF HUMAN HABITATIONS IN PRE-HISTORIC TIMES.

By E. DOBSON, M. Inst. C.E.

The object of this paper is not so much to advance theories as to formulate lines of enquiry, which, if steadily followed up for a few years, may probably lead to important historical and ethnological results.

The attention of the writer was first seriously drawn to this subject by the study of Butcher and Lang's translation of the Odyssey, the special passage which rivetted his attention being in connection with the description of the slaughter of the suitors in the palace of Ulysses at Ithaca.

I need hardly observe that a great deal of scientific research has been bestowed on the arrangement of that palace, as described by Homer, without any definite result. If, however, instead of trying to evoke out of our own consciousness the idea of the plan of a Greek mansion to fit Homer's description, we turn to the actual remains of the houses of the better class in Pompeii, the architecture of which was specially Greek in character, we have no difficulty in reconstructing the leading features of Homer's description, and in the plan of the house of Sallust (so-called) we find all the essential features of the home of the Ithacan hero.

There is the women's quarter, wholly separated from the rest of the house, and approached by a single door guarded by a slave, for whom a cubiculum was provided. There are

the mills for grinding meal close to the large hall, and we can understand how the pseudo-beggar, lying on the pavement, heard distinctly the lamentations of the unhappy girl who was kept up late at night to grind for the importunate suitors. There is the entrance from the back street, which was so carefully guarded, and the narrow passage, against the wall of which the naughty girls who had so misbehaved themselves were made to stand in a row whilst the halters were adjusted round their necks ; and with this plan before us, the whole scene becomes vividly real, and we have no doubt that Homer's description was not ideal, but perfectly realistic, and that we have handed down to us in the Pompeian mansion a faithful tradition of the plan of the Greek house of Homer's time.

Now Homer speaks of the principal apartment in the palace as the "*tholos*," which Butcher and Lang translate as the "hearth dome," a term evidently handed down from former ages, when the "house" was simply a round domical hut with a central hearth, on which burned continually the sacred fire, which symbolized the leading object of worship.

Grecian architecture, however, whether domestic, civil, or religious, was essentially of a rectangular type, no suggestion being apparent of circular plans or of domed roofs, which came into use at a later date with the development of Roman forms.

We must therefore conclude that the term *tholos* had been handed down probably for many centuries, and had come to mean *par excellence* the "house place," without any reference to the original meaning of the word.

An exception must, however, be made from the generally rectangular style of Greek architecture in respect of the circular stone domes known as "treasuries," of which the so-called Treasury of Atreus, at Mycenæ, is one of the best examples. It has three special characteristics—the entrance passage, the circular domed hall, and the small adjacent chamber, rectangular in plan. And this noted example of structures of this class fulfils in every respect the conditions of the building in which Danæ was confined, which has been described as a brazen tower, a treasure house, and a tomb. It was customary to deposit treasures in tombs for the sake of the security afforded by the respect shown to the memory of the dead, and the brazen character of the structure is evidenced by the nails still remaining with which the bronze

plates were attached to the masonry of the walls. As for the shower of gold which enabled Danæ's lover to approach her, it is simply a synonym for the golden key which will unlock the deepest dungeon.

These structures were probably all built to serve as treasure tombs, and are far older than the rectangular flat-roofed buildings of Homer's time, to which they appear to have no relation; yet in distant countries having no historical connection with Greece we find similar buildings, as the stone beehive huts of Upper Burmah and the Pict's houses of Scotland.

Now let us trace the earliest attainable records of the circular hut.

In the ancient necropolis cut through in the time of Cicero by the engineers employed under the tribune Clodius in laying out the road through Alba Longa, a necropolis which, even at that remote date, had been buried for unknown ages under the tufas of the extinct volcano of Mont Albano, are found cremation vases containing terra cotta models of the departed, with their furniture, tools, and houses, the type of house being the circular or slightly elliptical domed hut, the early type of the form which has prevailed with slight alteration through a large portion of the world to the present day. The walls batter slightly inwards. The doorway is trapezoidal in shape, and there are two openings over it in the roof for the double purpose of admitting light and emitting smoke, whilst the thatch of the domed roof is kept in place by forked tree roots, an arrangement which we find copied as an unmeaning ornament in the curved roofs of Lower Bengal at the present day.

Is it too much to suppose that in these terra cottas we have before us the material representation of the original house, the "*tholos*," the "hearth dome," of a far-distant age? Was this the form of the hut of Romulus, religiously kept for so many centuries in the Capitol at Rome?

That the use of this form was widespread is shown by the cremation urns dug up from time to time in Germany, but known by the name of "house-urns." They are copied from the same type, but are ruder in execution, the door with its wicker bolt so carefully modelled in the Mont Albano examples giving way to a simple lid with holes, by which it was tied on to the pot, probably with leather thongs.

Going northward from Rome we find the circular form of

hut in the old Swiss lake dwellings, and there is curious pottery extant, showing that when a house was required giving more accommodation than could be given in a single hut, several round huts were grouped together.

Going still further north we find the circular form prevailing in the North of Europe, with the curious feature that the houses are approached by a sort of burrow, with low narrow entrances, apparently designed as a protection against wild beasts. The domes built by the Esquimaux of frozen snow, approached by a tunnel, appear to be the most scientific development of this style of building, which in their hands approaches almost to architecture; but the leading features of this class of structures are to be found in the tombs of the Vikings, in the rude huts of Russian Lapland, and the Picts' houses in Scotland, whilst it is impossible not to see in these structures a rude resemblance to the subterranean prison of Danæ at Mycenæ, referred to at the commencement of this paper.

Going south instead of north, we find the round hut almost universal, except in the Nile Valley, where circular forms appear unknown; and in one of the woodcuts illustrating Stanley's " Darkest Africa " we have a perfect reproduction of the design of the Mont Albano terra cottas.

Further, Lt.-Col. Knollys, writing in *Blackwood*, May, 1891, has this remarkable passage in reference to the natives of Zululand :—" The native mind is characterised by a curious incapacity to imagine any shape beyond a circle, and consequently the kraals are enclosed by an annulus, with a flimsy outside fencing and an inside paling, where the cattle are penned."

There is a curious corroboration of this in Barth's Travels in North Africa, where there is an illustration of an African homestead, which consists of a circular clay wall, within which are the divisions allotted to cooking, sleeping, and the stalling of live stock. This is a remarkable instance, because the enclosure being only partially roofed over, there does not seem any reason for not employing the more convenient rectangular form for the enclosure.

The circular form of enclosure appears, however, to have found favour elsewhere than in Africa.

The Assyrian towns appear to have been surrounded with circular walls strengthened by towers, and a very interesting example of this kind of fortification is now being explored and measured at Sendschisli in Asia Minor. The rectangular

form of enclosure, or the rectangle with rounded corners, appears to have come into use at a later period.

Cæsar describes the British towns as being clearings in the forest surrounded by a circular enclosure, within which the cattle were penned, and the huts of the town dwellers erected.

The groups of hut circles in the south-west of England which mark the sites of old British towns show that the body of the house was excavated, the eaves of the roof resting on the ground; but the bas-reliefs on Trajan's column at Rome show the circular domed hut with upright walls.

With Roman occupation came in the rectangular style of building, and no permanent traces remain in England or France of the early use of the circle as a constructive form, with the exception of the circles of upright stones known as Druidical, which appear to be in some way connected with serpent worship, although the temples in Cambodia, built for this cult, show no trace of circular forms.

In Sardinia, however, there is a profusion of the strange circular towers called núraghs, which have the peculiarity of a diminutive entrance leading by a kind of tunnel in the thickness of the wall to the central chamber.

Curiously enough the construction of these ruined riddles is attributed to a race said to have crossed over from Africa at an early date, whilst in South Africa are now being explored the circular ruins in Mashonaland which are exciting so much curiosity, and which, so far as can be understood from verbal description, appear to have an analogy with the Sardinian núraghs.

And here may be said to end the record of what we know of the early use of circular forms in building. Asia Minor, Assyria, and China exhibit everywhere rectangular types of structure. Crossing the Atlantic, neither in Peru, Yucatan, Mexico, or Arizona do we find anything but rectangular types, with one exception—in the barrack-like erections of the abandoned pueblos of Western North America we find the *estufa*, or council chamber, on the central hearth of which always burned the sacred fire, to be of a circular form, blocked out from the rectangular walls within which it was enclosed; and this seems to bring us back to the "tholos" or hearth dome with which we started.

On the other hand, throughout Africa, with the exception of the Nile valley, and extending northward to the Arctic Circle, we find everywhere evidence of the early prevalence

of the use of circular forms, from the Zulu hut in South Africa to the snow dome of the Esquimaux of the Greenland shore.

What is the explanations of these facts? Was the use of the circle once universal, or was it confined within definite geographical limits? Is it a question of ethnology? We know from the evidence given in Miss Bird's travels in Japan, that there is a curious connection between the Esquimaux and the Ainos, the aboriginal inhabitants of Japan, also a diminutive, if not a dwarf race. The Picts were a dwarf race, and hairy, like the Ainos. The dwellers on the Swiss lakes were of small stature, as evidenced by the diminutive dimensions of the bracelets worn by their women. Was there any connection between these races and the dwarf races of Central Africa?

Had the original use of the circular form a religious significance, as would appear to be the case from the pains taken to retain the circular form of the estropas in the pueblos of Arizona? Or was it the only geometrical form which primitive man was able to describe, and does the use of the right angle mark a stage of progress in scientific knowledge?

It is so easy to strike out a circle on the ground with a string and a couple of pegs, and one is almost tempted to think when looking at the curious round churches in the Island of Bornholm, which were evidently set out in this way on a geometrical design, which was extensively used in the early days of Christianity as the groundwork of the pictorial representations of the Trinity, that this simplicity may have had a great deal to do with the matter. But when we come to look at the work of the mound-builders of the Mississippi valley, and see that this unknown race, who left no monuments whatever in the shape of buildings, must have been skilful geometricians to set out with precision the various figures presented by these curious earthworks, it does not seem that the production of a rectangle calls for a great exercise of talent.

It has not been thought worth while to encumber this paper with an enumeration of the works which may be referred to with advantage in the study of this interesting subject, as their names are legion, but a list is subjoined of the heads of inquiry to be kept in mind by those who have an opportunity of examining ancient buildings, or buildings which appear to have been erected on early types, and the author will gladly

receive any information of this kind to be tabulated for future comparison, the value of such notes being greatly enhanced if accompanied by sketches, no matter how rudely drawn, if accurate.

Appendix.

List of points to be noted in the examination of buildings which appear to illustrate the type of the original prehistoric house.

Material of construction.—Whether stone, clay, wood, turf, snow, &c.

Situations.—Standing in the open on the ground level, underground—as the Treasury of Atreus, above ground but buried under a mound, like the Picts' houses.

Approach.—Entered direct or with a tunnel of approach. (N.B. This last appears to be specially a Northern feature.)

Plan.—Rectangular, circular, or elliptical.

Walls.—Upright or battering inwards; openings for light.

Doorways.—Rectangular or trapezoidal; of full size or of purposely contracted dimensions.

Roofs.—Domed or ridged; roof opening over doorway, single or double; nature of covering; if of thatch, how weighted.

Notes to be accompanied, if possible, with sketches and dimensions.

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7.—THE TRUTHFUL TREATMENT OF BRICK-WORK.

By ALEX. NORTH.

General Distribution of Brickmaking Materials.

Of all building materials none are more generally and plentifully distributed over the face of the whole earth than the argillaceous formations and deposits from which bricks can be made. These formations occur in every considerable country—almost in every district—and are confined to no particular geological period, although they occur more abundantly in the later deposits.

It is indeed because most clays have been thus recently deposited on the earth's surface that they are so accessible and useful to man. Older argillaceous formations have in many cases been changed into slates and shales, yet clays are so plentiful that not even a schoolboy is unacquainted with their uses and nature, if indeed he has not practically demonstrated their fitness for plastic purposes.

Surely the extensive distribution, the unusual accessibility, and the easy manipulation of clays fully explain the predominant position which brickwork now holds as a building material, whilst other facts which are equally self-evident as clearly point to its even more extensive employment in the near future!

Stone fit for building purposes is the exception, not the rule, and even in places where it abounds this material cannot always be utilised, because it is usually more expensive to fit stone for building operations than brick. This is especially the case in these colonies, where the rates paid for manual labour are high, and where the rapid completion of building contracts are usually considered important in order that a quick return may be made for money therein invested.

Timber is certainly a cheap and ready building material, but it is mostly used for erections which, in an architectural sense, must be considered as temporary. This material is not stored up by nature in such large quantities as clay; and although there may be sufficient timber in these colonies for present requirements, nevertheless the forests of Australia, like those of other countries, are measurable in extent, and the time will come when, following the example of more thickly peopled lands, timber erections will be less frequent, and brick buildings more plentiful.

Considering, therefore, the present, and probable future predominance of brickwork, it surely seems expedient that all those interested in the purity of architectural design in these newly peopled lands should occasionally take counsel together, and determine how closely their brick buildings are following the true principles of science and art.

In countries which possess some architectural remains of a former age, it is an easy matter to compare modern buildings with those of an earlier date, and thereby gauge the relative merits of each. Here we have not that advantage; but the pages of history are open to us in a manner that no former age enjoyed; science instructs us clearly; the accepted principles of art speak in no uncertain tone; and the printing press

has furnished us with the permanent records of each authority; therefore, if we faithfully study these guides, our conclusions will be fairly accurate.

Definition of a Brick.

Before proceeding further it may be well to arrive at some decision concerning the constitution of a brick. Surely it is an actual "stone," the elements of which were formed on the ocean floor or in the bed of some lake, just as all stratified rocks are formed, with sediment brought down by rivers from some land near by. Mechanical agencies have triturated these denuded particles, carried them to such a distance from land as to be freed from coarser matter, and then in suitable places they have been collected, ground, and kneaded in nature's great laboratory, and then elevated above the ocean line. The work of pressing and burning a portion into bricks has been reserved for the hand of man, and herein it differs somewhat from ordinary sedimentary stone, though it bears a striking analogy to metamorphic rock, the difference being that a brick is quarried and shaped before it is pressed and hardened, while the stone must be shaped after its construction is completed.

The nominal size of a common brick is $9'' \times 4\frac{1}{2}'' \times 3''$, but some clays are worked up into different sizes and shapes, whilst others are capable of receiving a high degree of ornamentation and finish. Such are the various terra cottas, roofing tiles, decorative tiles, and ceramic mosaics; but for the purposes of this paper they must all be included under the general and comprehensive term of Brickwork.

History of Brickwork.

For ages past bricks have been one of the recognised building materials. Masters whose reputations are beyond dispute have not scrupled to use burnt clay in constructing some of the noblest buildings which have adorned the earth, and it cannot be doubted that in the hands of skilful artists most brilliant results have been effected from the employment of this material.

Historic antiquity abounds with instances of the honorable employment of brickwork, but we must look to a far remoter age for the first evidences of the ceramic art.

Recent investigations have thrown much light on the conditions of pre-historic man, and the state of society as it then

existed, but few archæological discoveries are of more interest than those demonstrating the abundance of pottery even so far back as the later Stone age.

Some recovered examples of the later Neolithic period have considerable merit, but as we go further back into the dim abyss of more distant times such ceramic examples as have yet been obtained become more rude both in construction and design, though there is every reason to believe that some of the cruder pottery belongs to the later part of the earlier Stone age.

We can well imagine some rude representative of palæolithic man, seated by the side of a gently flowing stream, where the action of water had laid bare a deposit of soft plastic clay, and watch him take up the material in his hands, roll it, and turn it into all manner of fantastic shapes, and then try to fashion it into toy imitations of his stone implements or cooking utensils. Possibly he might find that the frequent addition of a little water would greatly facilitate his labours, and that the sun would give a certain degree of hardness to his work; but it may only have been accident, or the childish glee of playing with a mock cooking utensil, which first taught him the importance of fire for giving permanency to his works.

Such speculation as this may appear fanciful, but the real birth of brickmaking belongs to the Stone age, and the probabilities are that it originated in such a manner as I have suggested.

We do not know the precise date at which brickwork was first introduced as a building material, yet it has long been recognised that sun-dried bricks were used in Egypt from a very early age; and recent discoveries have established the fact that kiln-burnt bricks can also claim great prehistoric antiquity.*

At a later period in Egyptian history, round brick-kilns, very similar to those used at the present day, are depicted in mural paintings; and in these terra cotta tablets were burnt, on which writings had been previously modelled. We do not

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* Professor A. H. Sayce says :—" Kiln-burnt bricks of an early date are found in Upper Egypt as well as in the Delta. The bricks composing the old fortress of Gebelên, south of Thebes, are stamped with the cartouches of Ramen-kheper and Isis-m-kheb of the (illegitimate) XXI. Dynasty . . . . Last winter I found the remains of a kiln where some of the stamped bricks had been burnt before being used for building purposes. A portion of one of them, with the cartouche of Isis-m-kheb, lies before me at the present moment."—*Building News*, Vol. LI., p. 185.

find that brickwork prevailed in Egypt as an extensive building material, and this cannot be wondered at, for desirable building stone was procurable as well as the labour to work it; consequently stone was used for the more important buildings, whilst reeds were largely employed for humbler structures.

Such, however, was not the case in the centres of Assyrian and Chaldean civilization; consequently the prevailing character of the country caused brickwork to predominate above all other materials for structural as well as documentary purposes.

Unburnt bricks were largely used, cemented together with bitumen. These have now mostly returned to the earth they were, and leave little for us to see, except mounds marking the site of former cities and buildings.

Nevertheless, a high class of ceramic art was developed, and terra cotta ornaments and plaques were extensively made, to whose durability we are indebted for much we now know concerning the history and customs of those ancient nations.

From the natural characteristics of Greece we should not expect to find many remnants of brickwork. A country abundantly supplied with the choicest of stones, and clothed with forests of good building timber, would not be likely to expend much energy on brick buildings; but had the conditions of that country favoured the manufacture and employment of brickwork, we might reasonably have expected to find there examples of that high artistic merit which is so indelibly stamped on the other productions of ancient Greece.

The Romans were, however, the first nation to raise brickwork to the dignity it deserved, and, strange to say, some of their best works are to be found executed with bricks and tiles. In stone-building the Romans slavishly followed Greek precedent, and in their plagiarism lost the true artistic ring of the original; but in brickwork they have left behind them the great redeeming feature of their architecture.

Notwithstanding the apparent similarity of Roman and Greek buildings, this epoch marked the greatest change of architectural evolution. I refer to the introduction of the arch and dome as a recognised principle of architectural art.

The nature of bricks and terra cotta render their employment in large blocks an impossibility, as the material of which they are composed is liable to warp and crack during the processes of drying and burning should the blocks

operated upon be above the maximum size. Under these conditions brick lintels of any ordinary size are an impossibility; but the introduction of the "Arch" and "Dome" rendered it possible to span large openings with small wedge-shaped blocks, and thus, not only the Romans, but subsequent builders, have been able to execute works of great utility and merit in the humblest of building materials.

Apart, however, from the introduction of the arch, Roman brickwork deserves more than a passing notice on account of its many other excellent characteristics; indeed we might do worse than revive many of its good qualities which have now fallen into disuse.

Whilst modern bricks are for all practical purposes of one uniform size, Roman bricks were made according to various patterns so as to best suit them to the quality of the material at hand and the class of workmanship required. Usually they were about double the length of our modern bricks, of a proportionate width, and but $1\frac{1}{2}$ in. in thickness. This size has many advantages which recommend its introduction, for it is self-apparent that a thin brick will be more thoroughly burned than a thick one, all other conditions being equal. The thorough burning of a brick is in fact one of the most important items in brickwork, for thereby its imperviousness to moisture, its appearance, its strength and its durability are ensured. The greater length of the Roman brick assisted materially in a thorough bonding of the work, such as is indeed impossible with our short bricks.

When building walls the Romans did not appear to lay much stress on the thinness of the joint; their mortar, however, was, as a rule, far superior to ours, and in this they thoroughly embedded their bricks, entirely surrounding them on all sides with mortar, so that their walls formed a solid block without any interstices. The modern practice of laying bricks on a badly prepared bed of sand and lime, with a trowel splash of the same material along the outer edge of the vertical joint, is unknown in Roman work; yet this undesirable modern custom is so universally practised by bricklayers of the present day that unless the setting of every brick is personally supervised it seems hopeless to effect any improvement.

Durability of Brickwork.

Concerning the durability of Roman brickwork there can be no question, for not only are well preserved ruins abun-

dant in many parts of the Roman world, but buildings still in use yet remain as living witnesses.

The great Central Tower of St. Alban's Cathedral was built in Norman times, but with Roman bricks which had previously formed the walls of Verulam.

Ordinary building-stone would long ago have crumbled away under the trying influence of English climate, but the material of which this tower is built still promises to bid defiance to the denuding ravages of time for many ages yet to come.

I was present during the excavations for the extension of one of the Metropolitan railways, when a portion of the old Roman London Wall was laid bare, and I had the good fortune to secure some of the bricks; they were of the usual Roman type, long, broad and thin, but perfectly sound and so hard that they might still be pronounced as most desirable building material.

Another type of brick often used by Roman builders is the triangular. This was built with one base to the face of the wall and the apex pointing to the centre, which was afterwards filled up with concrete, and formed a construction of great strength and durability.

Tesselated pavements, whose beauty and utility are so generally recognised, were often employed by the Romans; whilst their frequent discovery in a climate such as that of England is sufficient guarantee as to their surprising endurance resisting the effect of wear and time.

During the middle ages brickwork was little used in England, at least for important buildings, but towards the closing years of the Tudor dynasty its revival was most marked, and we find shortly after that time such important buildings as Hampton Court Palace and St. James' Palace were executed with bricks of good quality.

In the north of Italy a composite style of brick and marble architecture dating back to the Middle Ages was largely used, and so meritorious are many of these constructions that one of the most renowned of modern architects, the late Mr. G. E. Street, R.A., did not deem it waste of time to write a professional work, entitled "The Brick and Marble Architecture of Northern Italy."

Other great centres of brick-building during the last few centuries also exist, notably Holland, Belgium, and Northern Germany. These great districts are ill supplied with good building-stone, but have shown what can be accomplished in brickwork.

Present State of Brickwork.

From the past let us glance at the present, and then we may perhaps be possessed of sufficient data to guide us in speculating on the future possibilities of brickwork. Surely it would be no difficult task to picture in our minds a typical modern brick building,—not an isolated example, but one of a type which prevails in almost every Australian City, and for the matter of that in the towns and cities of many other countries also.

Some little time ago I was much amused at hearing a modern writer of fiction term the reign of George III. "the reign of ugliness;" but if I was asked for the most appropriate designation of the present architectural age, I should have little hesitation in dubbing it "the reign of deception." We would not now tolerate miles of bald and unlovely Gower-street fronts, with their never-ending straight lines, square window and door slits, and monotonous bricky tinge; yet our average brick building is constructionally inferior to the Georgian type, although we are unceasingly attempting to persuade ourselves of its vast superiority. We place deceptive masks on our modern brick buildings, and follow up the farce by calling them Greek, Roman, Renaissance, or Queen Anne, but in each case the mask is slightly askew, and we recognise familiar features and a well known voice chuckling—"I'm 19th century for all that—is not it a good deception?" But why is the modern character so indelibly written on the average brick building? Simply because every nerve is strained, not to give a faithful material, not to provide the most durable and rational construction, but to erect a building which shall seem better than it really is. Every effort is made to produce material at as low a cost as possible, and consequently its efficiency must be impaired. It would be unreasonable to expect a brickmaker to concentrate all his energy in the production of an unsurpassable article, when the first and sometimes only question an intending purchaser will ask is the lowest figure per thousand at which the bricks can be supplied. Occasionally the quality of the material may be a matter of importance with brick-buyers, but as a rule, if the article is cheap and passable it will not be considered whether the bricks were the most suitable and best procurable or not. Little wonder, then, that the average building is composed of bricks and mortar also, which in more respects than one might have been greatly improved had sufficient inducement been offered to the pro-

ducers to make something better. We can hardly blame manufacturers for the present state of things, because competition will not permit them to give more than is demanded. Neither can we altogether blame builders or their employers, for they must cut their coat acccording to the cloth and yet keep up appearances. The evil lies in the spirit of the age, which looks for ostentation at the expense of truth.

No doubt good individual bricks are now made, perhaps of better quality than those of any previous age. This is a cheering fact, for it shows the possibilities of modern work; yet, on the other hand, it cannot be doubted but that the average brick of any previous period from Roman times downward is a better article than that now commonly used. Such being the case, it has become the custom to plaster over the most exposed brick fronts with a thin coating of stucco or cement in order to render the walls more impervious to moisture, to protect outside faces from rapid denudation, and to hide ugly bricks, slovenly workmanship, or other defects. In this manner the popular conscience is satisfied; for a weak, unsound, and partially decomposed building has at all events received the outward appearance of strength and durability.

The spirit of deception once being admitted, proves contagious; consequently even in cases where good material is obtainable, and no other essential difficulty in the way, we find a gaudy and ostentatious cement front preferred to sound honest brickwork.

If it be true that the architecture of a given period is but a petrified reflection of the characteristics of the people, what are the impressions which a modern brick building will leave for the criticism of the future archæologist?

Shall we say that bad bricks and mortar tell of that tyrant competition—the most relentless and remorseless the world has yet seen?—shall we say that the poverty of originality in modern designs is explanatory of that plagiarism which cheap literature has placed in the hands of the half-educated?—shall we say that the superfluity of gaudy and ill-chosen ornament represents the ostentation of the age?—whilst the thin coating of typical cement is but the mask which barely veils the fraud and deception of so many every-day transactions from a not too enquiring world.

It is a prostitution of sincerity, truth, and good sense to plaster over a thin brick wall in order to represent ashlar, delicately carved trusses and ornamentation, massive cornices, and impossible lintels, all resting on a ponderous base of huge

mock stones. Such a building can never be anything but an unmitigated sham, repugnant to art and incongruous to science; yet it is a fair representation of the average modern building.

Ruskin lays down the axiom that construction may be ornamented, but that ornament ought not to be constructed; yet cement fronts of the present time are usually constructive ornament in its most unblushing form. I do not mean to say that cement is not a legitimate building material, even for decorative purposes,—on the contrary, it has many sterling qualities to recommend its use; but the facility with which it lends itself to the imitation of stonework is not one of them.

The practice of plastering exterior wall faces is not altogether of modern origin; but whenever it was used in former days it was employed in such a manner as to truthfully proclaim its nature, for no attempt was ever made to imitate stone, or indeed any other material. In order to explain my meaning I refer you to the sheet of sketches I have made, where some of the old methods of treating external plaster-work are depicted.

One indomitable law of nature is always in force, that is, change. Sometimes alterations may be difficult to discern, at other times their rapidity is more accentuated, and from present indications I believe the near future will see a great change in the popular appreciation of brick architecture. In many parts of the Old World a most decided revulsion against the monotonous and insipid tint of cement, and a desire to return to honest brickwork, is manifested. Even in Australia the public seem to be more tolerant of brick facings than formerly, and I feel convinced that a decided preference for good brickwork would soon become more general if sound material of a pleasing tone was more largely produced.

Unfortunately, our bricks are usually of a very uneven colour, varying in tint to such an extent as to render anything like uniformity almost impossible. Even where bricks resemble each other in colour the general tone is usually anything but pleasing, so that sometimes the work will look pale and insipid, sometimes dark and dingy, and at other times fiercely glaring, but seldom of that warm subdued tone which leaves such a pleasant memory in the mind.

Tuck-pointing.

In order to overcome uneven colour and objectionable tone, it is usually considered essential that brick faces should be

tuck-pointed. This means washing over the bricks with some colouring material, raking out the mortar joints and then filling them with a stopping of the same colour as the bricks, after which thin white lines are run along the joints to imitate fine mortar. This cannot be considered a truthful mode of construction. It is an attempt to make the work look better than it is. Besides, tuck-pointing is not sound work : sooner or later it will disclose its artificial nature, and no tuck-pointed building will ever beautify with age like plain brick-work. A few years will suffice to make a neat cement or tuck-pointed front look shabby; but to no other building material does the mellowing effects of time deal more kindly than with sound honest brickwork, toning down hard lines, and subduing tints too bright, or adding that picturesqueness which time alone can give, but never making the work look mean.

I do not like tuck-pointing, but practical experience has taught me that it is an evil which the architect must frequently endure if he would save himself from something worse. In the majority of cases in Australia it is not possible to get bricks and mortar of such a quality as to warrant the non-requirement of the tuck-pointer's services. There are, however, exceptions to every rule, but only once have I had the good fortune to supervise a non-tuckpointed brick building in Tasmania with which I felt perfectly satisfied. I refer to the Roman Catholic Church "Star of the Sea," recently erected at Burnie.

In this instance the bricks were almost perfect, fairly true and even in size; they were of a rich, warm, and pleasing tone, not too glaring, and what is in this country unusual, the tint was almost uniform. In addition to this the general contractor and bricklayer were men who thoroughly understood their work, and took a most praiseworthy interest in rendering the building as perfect as it could be made. The bricks were manufactured by Mr. W. Jones, of Burnie. The terra cotta and moulded bricks were made by Mr. J. Campbell, of Launceston. The general contractor was Mr. T. Kenner, of Burnie, and the foreman bricklayer was Mr. J. Hills, of Launceston. A sketch of a portion of this church is among the drawings presented.

Brick-earths.

All clays are not equally suitable for brickmaking ; some are deficient in the necessary mineral properties, whilst others

are rendered useless by reason of the excess or improper incorporation of certain substances. Good brick-earth is seldom found in a natural state fit for the purpose of making a high-class brick without the addition or extraction of certain constituents. Even where brick-earth does exist of the required balance for making sound ordinary bricks, such material is not likely to produce an article suitable for facings of the required finish and tone.

A good brick-earth should contain from $\frac{1}{5}$ to $\frac{1}{3}$ alumina, $\frac{1}{2}$ to $\frac{3}{5}$ silica, and the rest of its bulk should consist of carbonate of lime, carbonate of magnesia, and oxide of iron, besides which there will necessarily be a small percentage of other mineral substances, and perhaps of organic matter. The above proportions are not likely to make the bricks vitrify to such an extent that they will run together, yet they contain sufficient flux to fuse the various constituents at furnace heat.

If a clay is too strong—that is, almost wholly composed of silica and alumina, without a sufficient proportion of lime, magnesia, soda, or other salts—then such clays can be improved by the addition of sand, or loam and lime, to act as a flux, or ashes to provide alkalies for the same purpose.

If a clay is too loamy or sandy, then it is absolutely necessary that great attention should be paid to providing the necessary flux, or the particles will not properly combine.

Marls are the best of all natural clays for brick-making purposes, though they are often improved by the addition of frequently deficient substances.

Many mineral substances besides those already mentioned frequently enter into the composition of brick-earths, some improving and others depreciating the value of the material; and although chemical analysis may be of great service in guiding the brick-making experimentor, it must be borne in mind that nothing short of practically making and burning a sample brick will be a satisfactory test, as frequently the substances are in combination with one another when they would be better separate, or in some other chemical state which renders them of little or no service for practical purposes.

The tint of a brick may be much affected by the different processes of manufacture, but the presence of such substances as lime, oxide of iron, manganese, alkalies, &c. are the greatest coloring factors in brick-earths. In order that a brick building may have a true artistic finish it is absolutely necessary that the facings should be of a pleasing tone, yet, as I have already

said, such bricks are most difficult to get here. In many parts of Europe and America the demand for brick fronts is so great that the country has been prospected for brick-earths of a desirable kind, and these are now worked and sometimes forwarded to great distances by rail.

Such is not generally the case in Australia, not because the proper brick-earths do not exist, but because the demand for high-class work is so very restricted. The various colonies are rapidly becoming netted with railways, so accessibility to the best deposits will be easier when the time arrives for their utilisation, but that time will not arrive until the public are in deeper sympathy with artistic brickwork.

Mortar.

Besides bricks, another very important factor is needed in order to make brickwork—that is, mortar. Lime, of course, is the most important feature in all mortars, not excluding cements, and its strength depends on the class to which it belongs, the proportion of its combination with other substances, and the mode of its manufacture.

Everybody is aware of the importance of cement in making a reliable and non-skrinking mortar, but as it is used principally for piers under great pressure, additions to existing structures, and other important works, rather than as an ordinary building mortar, I do not propose to follow up this subject.

Building limes may be divided into four classes:—

1. Fat limes.
2. Feebly hydraulic limes.
3. Moderately hydraulic limes, and
4. Eminently hydraulic limes.

Fat limes are calcined from such materials as chalk, pure marble, oolitic limestones, and shells. They throw off much heat in slaking, and set badly. Although they may be of service for sanitary purposes and plastering, they make poor mortar, and ought not to be used in any important work, as unfortunately is frequently the case.

Hydraulic limes owe their property to some other material contained in the stone. Many different substances tend to produce hydraulicity, but the principal constituent is clay, and upon the proportion of the combination depends the quality of the building lime.

Some hydraulic limes slake slowly, others with difficulty, whilst a few require to be ground. Feebly hydraulic limes

do not set in a moist place, nor do they ever attain any great degree of hardness.

Moderately hydraulic limes will set in a permanently moist position, and eventually become as hard as a soft stone, whilst eminently hydraulic limes will set even in water, and possess the characteristics of hard stone.

Sometimes fat limes are artificially rendered hydraulic by moderately calcining an intimate mixture of fat lime with the same quantity of clay as is found incorporated with hydraulic limestones, and this is a practice which might be more extensively employed in districts possessing only poor limes.

Although fat limes attain a fair degree of hardness when exposed to a dry atmosphere, yet I have found mortars composed of such limes to be soft in the centre of a wall.

I have also made concrete briques of fat lime mortar, and after the composition has hardened I have buried it, and then after the lapse of a few months dug it up, only to find the concrete again in a plastic state. On one occasion I had to make additions to an important building in Launceston which showed signs of extensive settlement. The foundations were of lime concrete, but when excavations were made I found metal, sand, and earth, but could discern no trace of lime, for it had dissolved and had been carried away by drainage.

The advantages of a mortar-mill in thoroughly grinding and incorporating the various parts of mortar is very great. I wish its use were more general, for then we should not only get stronger mortar but also a less lumpy material, which would ensure better and neater brick-work.

Ancient Roman mortar has gained a reputation for strength and durability, and not without reason, for Roman mortar is now frequently found which is more difficult to break than the bricks and stone it formerly cemented together. Romans usually burnt lime on the spot where it was to be employed as mortar, then used it whilst it was fresh and hot, and often mixed it with pounded bricks instead of sand.

Laws of Construction.

Having now briefly considered the two great constituents of brick-work, it may be well to determine their legitimate office.

Constructionally speaking, brick architecture is essentially a style of arches, for, as I have already said, its component parts are too small for lintels, although they are eminently

adapted for forming arches which may span far greater distances than the giant builders of Egypt ever dreamt of covering.

Arches, indeed, are one of the great charms of brick architecture; they are more picturesque than the lintel, and provided sufficient abutment can be obtained, they are decidedly stronger. Yet it is a fact that notwithstanding all the advantages conferred by the introduction of a legitimate arch, human intellect has sunk so low as to invent that inartistic and unconstructional abomination called the "flat arch." This is nothing less than an imitation of the lintel. Beauty it has none, and it would really seem as though it were considered meritorious to execute the weakest of constructions with the most inappropriate of materials, simply because it offends good taste. Notwithstanding all the drawbacks of the flat arch, it still lives in reigning popularity, and pages have been written in works on Building Construction informing the student how it is possible to build this unlovely arch so that it will not fall.

Within the limits of a short paper it would be impossible to enumerate all features which should be avoided in brick construction, or to mention all those which may be legitimately employed.

I will merely say that such features as projecting quoins, pediments, architraves, large cornices, columns serving no constructional purpose, together with any ornament or embellishment which may serve to suggest the employment of any other material, should be rigorously avoided. There is more connection between art and common sense than most people imagine, therefore if a building violates no principle of construction, participates in no imposture, is decorous in its embellishments, and truly serves the purpose for which it was erected, it can scarcely fail to achieve some artistic merit.

The practitioner of the present day is no doubt crippled in his endeavours to produce the best types of artistic brickwork on account of the uniformity in the size of modern bricks. It may not be generally known that the present shape is the result of a tax which was imposed on bricks during the early part of the present century, rendered necessary by the long and costly wars in which England was then engaged.

The brick tax no longer exists, even in England, yet not only in that country, but here also, we must confess to being so much the slaves of habit that we have been unable to enjoy the sweets of liberty now that our freedom is declared.

It is very questionable whether or not the present size is the best shaped brick which could be employed for general purposes, while there is certainly no doubt that it is not sufficient for giving a builder the scope he should have in the treatment of his subject. In England many mouldings, and even carvings, are executed in what are called cutters and rubbers. These are specially made bricks, highly tempered with suitable sand, and, when properly worked, are capable of showing lines almost as sharp and clear as freestone.

I cannot altogether approve of the employment of cutters, although they are at times useful, for naturally the softest bricks are used, and no brick is so durable as it otherwise would be after its kiln face is removed. A much more preferable method is the employment of purposely made bricks or mouldings, and terra cotta work for ornamentation.

Moulded bricks are now made in considerable variety, and although they cannot be finished to such an accurate line as cutters, still they have the advantage of being cheap, truthful, effective, and far more durable than cut bricks, cement, or freestone.

No material for cheap and vigorous decoration is better than terra cotta. It can be modelled whilst still plastic, and then burnt into one of the hardest and most imperishable of building materials. In towns especially terra cotta has much to recommend its use, for those gases in the atmosphere which play such an important part in the decomposition of freestone act much more leniently with the material now under discussion. Many of the leading English architects have not been slow to discover the advantages of terra cotta, but since its introduction as an accepted modern building material many failures have had to be recorded.

The key to nearly every failure is discovered in the attempt to make terra cotta act as a substitute for stone, instead of recognising that a new building material had come into existence requiring a treatment peculiarly its own. Attempts were made to manufacture blocks of too great a size, and, as a natural consequence, fractures, twists, and uneven shrinkage was the inevitable result.

During recent years many important buildings have been erected in terra cotta, among which may be mentioned The Prudential Assurance Office, Strand, London, and The Natural History Museum, South Kensington. Both these buildings were designed by Mr. Alfred Waterhouse, R.A., Architect, and have met with almost universal approval.

The latter building afforded the architect a splendid field for the display of his genius, and he has left there a rich record of the fauna of the world modelled in terra cotta, and so incorporated with the building as to form an integral part of its construction. This is as it should be, and the structure itself could not be mistaken for other than a Natural History Museum even without its contents, whilst, as a building it stands out prominently as an example of the possibilities of terra cotta construction.

Within the last twenty or thirty years a most marked revival of the applied arts has been progressing in England. This artistic revolution has once more thrown brickwork to the front, with the result that good bricks, capable of high artistic treatment, are now made to satisfy the public demand.

All lovers of honesty and purity in architecture must indeed be rejoiced at the better state of things now prevailing in the mother country, for they may rest assured that the movement once established in the great heart of the Empire will not be stayed until it has reached its remotest bounds.

Some time after the revival of brick as a modern artistic building material, its influence did not extend far beyond the limits of the metropolis, but as time rolled on it gained a foothold in first one and then another provincial centre, until at last its conquests extended beyond the seas.

In the United States of America the movement has been taken up by the artistic section of the community with an enthusiasm and vigour characteristic of that energetic people. It is not long since the Americans were regarded as a most inartistically disposed nation; they were known to be capable of carrying out big undertakings and perfecting ingenious labour-saving appliances, but America was the last country to which the enquirer after architectural truth would have turned; but now she is teaching the world valuable lessons in the artistic and truthful treatment of modern buildings.

Of course America is a large and heterogeneous country, and the modern revival of truthful brickwork is of such recent date that it would be unreasonable to expect examples of this architecture widely dispersed throughout the Western Continent. Yet they do exist in some of the more favoured localities, and promise, at no distant date, to be an important factor in architectural evolution.

As yet the popular taste for artistic brickwork has not reached Australia, but its arrival is merely a question of time. Scouts and pioneers are not lacking, but their success

is often impaired by the difficulty of securing appropriate material. When that time does arrive it should be hailed with satisfaction by all well-wishers of art and science, for brickwork is the material of the million, and its popular appreciation may be regarded as a sure index of improved public taste. I do not mean to say that brickwork will ever take the place of stone,—indeed such a possibility would be a calamity,—but it is well known that the cost of stonework precludes its use in all but exceptional instances, consequently the choice simply rests between brick and cement.

Tiles.

I cannot close this paper without speaking about tiles, which naturally come under the heading of brickwork. For flooring purposes they are now largely used, and every day increases their popularity, so that a great extension of their employment may be looked for in the near future. Those who put up permanent buildings know that in the long run a tiled pavement is cheaper than a wooden floor, for the former is practically indestructible, whereas the latter is liable to destruction by fungi, insects, or fire, besides being open to many sanitary objections.

Tiles for roofing purposes are little used in these colonies, yet there can be no question but that they form the most comfortable of all practical roof coverings, as well as the most artistic. Tiles are largely used as roof coverings in many parts of the world, from the north of Europe to Spain, Italy, Central and South America. Being non-conductors of heat and cold, their utility in a country subject to rapid changes of temperature cannot be over-estimated, and the wide extension of their use speaks powerfully in favour of the high estimation in which they are held.

As a practical illustration of the fact, I may mention that a large house recently erected under my supervision was covered partly with tiles and partly with galvanized corrugated iron. During a visit of inspection to the building a thermometer was placed under the tiles and another under the iron, whilst the sun was alike on both roofs, and the result was that the space under the tiles registered a temperature of 15° below the space under the iron covering. Slates, like metal, are conductors of heat and cold, and although buildings so covered may be stifling during the heat of day, yet they cool down so rapidly with a lowering external temperature as to be but little protection against cold.

Tiles are an ideal roof for Australian houses, where protection against the fierce rays of a relentless sun or the effect of a sudden chill are so much needed, and it seems difficult to understand why they have not been generally employed. Unlike iron or slates, they can be made on the spot, and those who would foster local industries could not do better than urge the use of tiled roofs.

For the inspection of those present I have brought with me a few samples of tiles which have been made in Launceston. Their quality is good, and wherever they have been used they have given satisfaction as a protection against weather, heat, cold, and the effect of condensation to which both slates and iron are subject. They have, however, one great defect—their harsh and glaring colour. No doubt this is a difficulty which may be overcome, and would be overcome if sufficient inducement was offered to the proprietor to turn out a really first-class article. For the bright sunshine of Australia a more subdued tone is required than would be acceptable in England, and this is a point which manufacturers should keep in view.

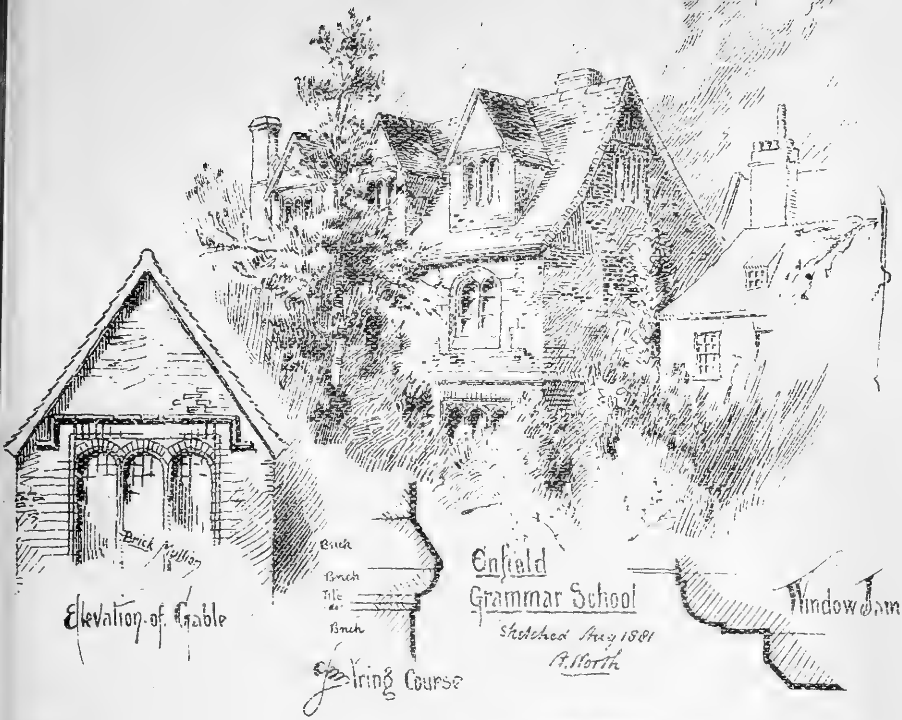
Notes on Illustrations.

No. 1. Grammar School at Enfield.—Although this building is erected in a style of architecture which cannot be altogether recommended for reproduction, nevertheless it shows some rather interesting and instructive examples of brick treatment. The jambs and heads of ground and second floor window openings are of brickwork as indicated by details, and it should also be noticed that the window mullions are likewise of brick. The hood moulds are of brick, also the string course, which shows that all possible care has been taken to turn water away from building.

No. 2. Doorway of No. 4, King's Bench Walk.—As its name would indicate, this doorway will be found in the "legal" quarters of the great metropolis. The locality generally is not one in which we would search for architectural treasures; in fact this building, like its neighbours, is cast in an unlovely mould, with no architectural pretensions beyond the entrance door. The brickwork of this entrance, however, is full of interest, and shows what good materials and good workmanship may accomplish.

No. 3. Buildings at Wakefield.—This sketch was inserted by mistake. Buildings I had intended to illustrate were some old houses at the corner of Marygate, Wakefield, which, in my opinion, are the best examples I have ever seen of the truthful and legitimate treatment of stuccoed fronts. My idea in presenting this sketch was to illustrate a pleasing stuccoed building,

1



Brick Mullion
Elevation of Gable
Brick
Brick
Tile
Brick
String Course
Enfield
Grammar School
Sketched Aug 1881
A. North
Window Jamb

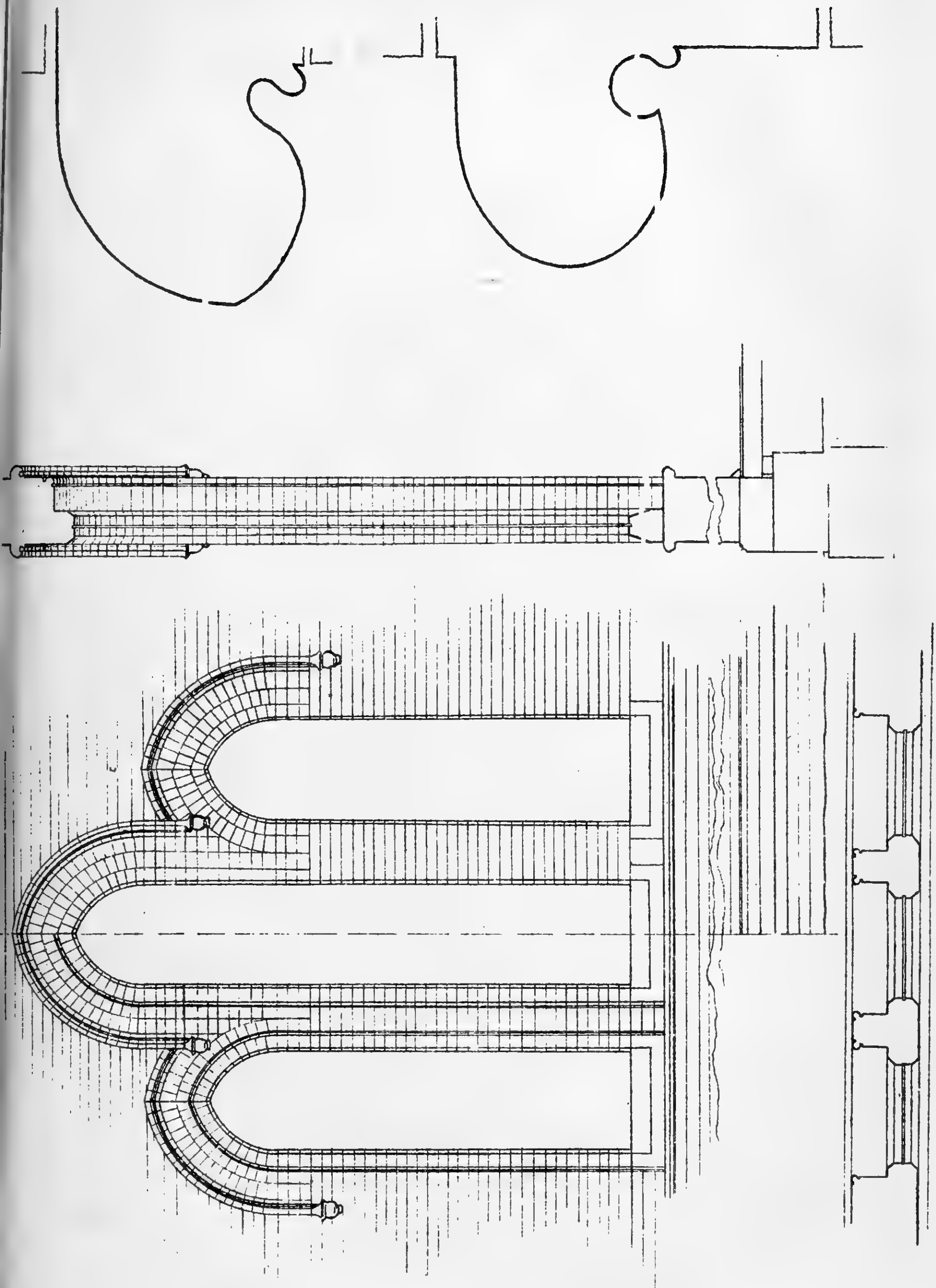
2

Detail of
Iron Rail
No 4 Kings Bench Walk
Temple . London
the following inscription is over door
Conflagratum An° 1677 Fabricatum An° 1678
Richardo Powell Armeger The faurar°
Sketched Ju. 1881
A. North
The doorway and pediment over same
are built with gauged Red Bricks.
The moldings & carvings are of cut Bricks.

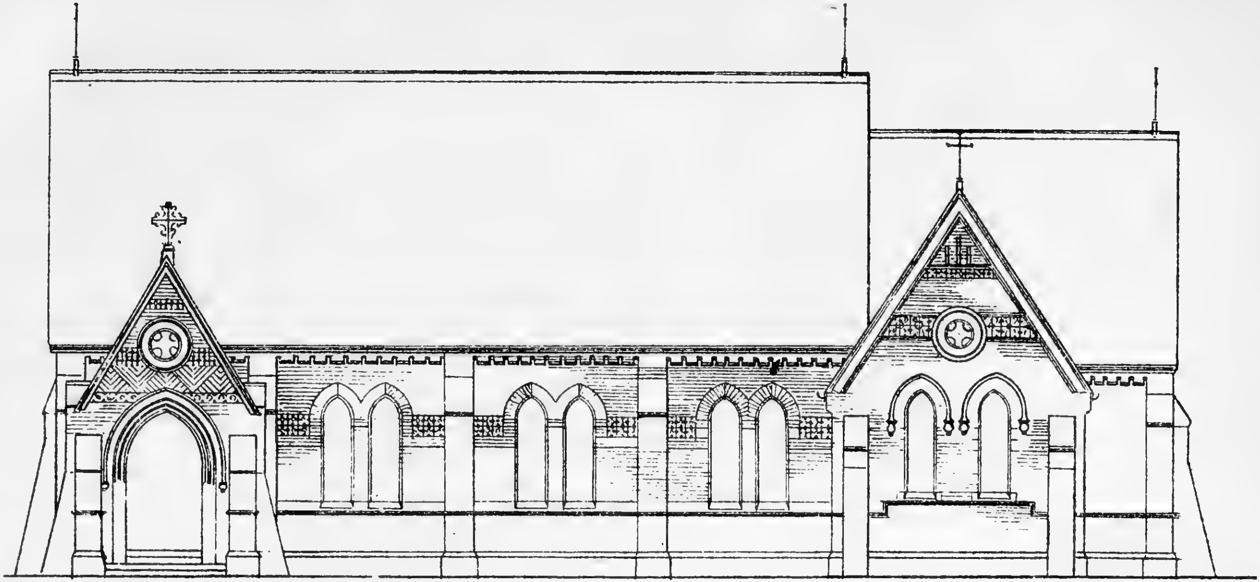
3

Old Houses - Westgate Wakefield

4



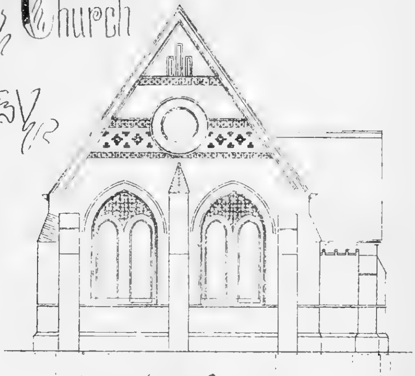
Holy Trinity Church — Cressy.



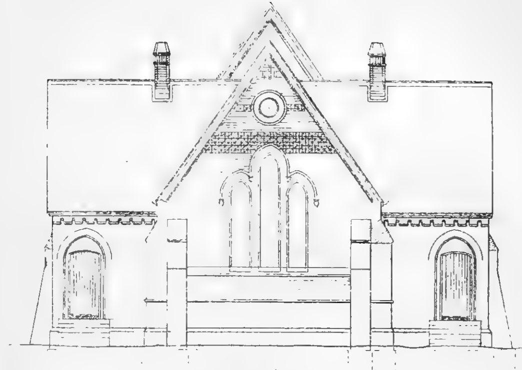
South Elevation

Corrie North Archt.
Launceston

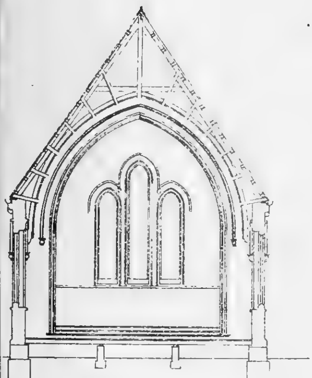
Holy Trinity Church Cressy



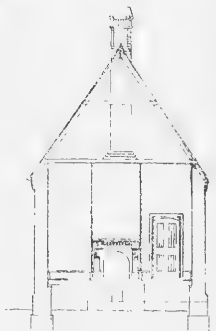
West Elevation



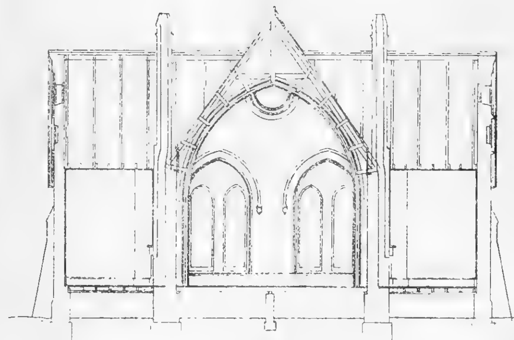
East Elevation



Section "AB" (looking East)



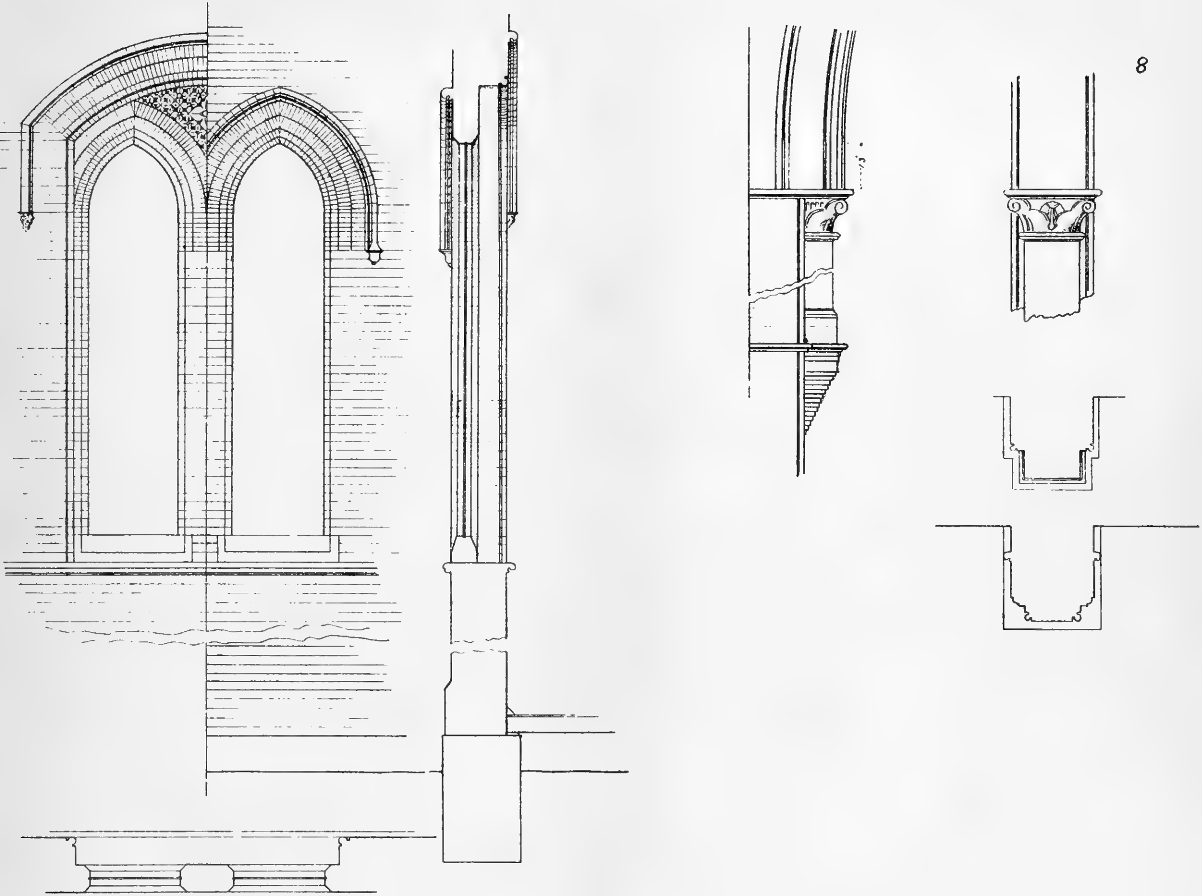
Section thro' Vestry "CD"



Section "EF" (looking west)

Corrie M.
a

8



whose design does not exhibit the least attempt at copying brick, stone, or timber construction. The old houses in Westgate, Wakefield, now shown, are of brickwork, with timbered and stuccoed gables. These gables, although not the best of their kind, do not imitate brick construction, although they are not free from other defects.

No. 4. *Porch of Star of the Sea Church, Emu Bay.*—This church has been recently erected from my designs, and the porch now illustrated is a typical example of the style of construction employed throughout. The whole of the design is carried out in brickwork, except the cross at apex of gable, which is worked in stone. All the water tablings of buttresses, copings, &c. are bricks set in cement, the cement being mixed with crushed bricks so as to avoid objectionable colour of cement mortar lines. The kiln-face of bricks is in all cases exposed to view, the cut and surface being towards the interior of wall.

Nos. 5, 6, *and* 7.—These are sheets of working drawings for proposed church of the Holy Trinity at Cressy, Tasmania.

No. 8.—This is a sheet of working details for proposed new church at Ulverstone, Tasmania. The walls are to be brick throughout, with decorative work in purpose-made bricks or terra cotta. The style of construction will be similar to that employed at Star of the Sea Church, Emu Bay.

8.—BRICK FRONTS TO BUILDINGS *VERSUS* CEMENT, AND *VICE VERSA*.

By W. W. ELDRIDGE, *Government Architect of Tasmania.*

You all, no doubt, have heard in your everyday life while walking the streets of different towns, cities, and country places, expressions of opinion upon various buildings, and especially in comparing the merits or otherwise of the appearance of one building with another. Now, I have heard many times of buildings covered with Portland cement compo condemned as shoddy, and I have also heard said "How fearfullyugly that building of brick is!" On the other hand, I have heard both classes of buildings praised. But the first opinions are often given, I think, without a proper knowledge of the subject, or even without being able to give a cause or just cause of the ugliness of such buildings. Of course such expressions are generally used by laymen, but certainly at times by professional men, which surprises me, as such opinions must be expressed from want of thought or proper

consideration, which no professional man should be devoid of if he wishes to rise in his profession, and if he has already risen without this it must have been by luck more than art in architecture; I say art, because architecture is a branch of art.

A great deal depends upon the site as to what material the building should be erected of, and all the surroundings should be observed, also the materials at hand. For a wealthy man the cost of materials would be of little consideration, but to a moderately well off man it would be different, and to a poor man a great difference, and thus the expense would have to be taken into consideration.

I would not advise a client wishing to build a house in the country and where surrounded by hills, say like Mount Wellington, with a dark brownish green foliage for a background, and the house proposed to be built to be somewhat elevated, to erect it with red bricks, but rather with a lighter material: the client may not be able to afford stone, what material then? Why, Portland cement compo (I would prefer stone or white bricks), which would not only give a sound weather-proof building, but also a building that would look well by seeming to stand out from the background. On the other hand, should the foliage be a light green or yellow green generally, or should there be white cliffs or hills surrounding the site, then a bright red brick building would be desirable, or a brick building with stone. I could say a good deal about stone buildings, but as my paper is short, and only for brick and cement structures, I must leave that for a future period. Cement dressings, especially if pressed and built in as masonry, have a good effect, and I cannot do better than refer to a red brick Gothic church in Prince's Square, Launceston, where the pressed cement is used in place of freestone throughout, and a splendid piece of work has been made of same. Now, I can see no objection to this, as the work has well done at a cheaper cost than if freestone had been used, the windows being similar and the mouldings the same; several moulds would do the whole of the work of casting, thereby saving a great cost which would have otherwise been incurred in stone-cutting and getting stone from distant qurrries, also the pressed cement being far superior to most of the freestones. In Hobart it would be a different matter, as the town is in the middle of stone quarries of different qualities.

Should a site be selected for building, and it has been decided to erect a red brick building, then a building giving

the same accommodation as a cemented one could be built at the same cost, and where the cemented ones would always have dry walls, so could the brick one be erected with hollow walls for the like purpose.

A great consideration must be given to cost, and this, and the appearance as to suitability of aspect of site and surroundings, should be taken into consideration together (whether the architect prefers red brick as his fad or Portland cement compo for the same reason, should not stand in the way of advising his client without prejudice,—this should be thrown entirely on one side), and he should take his material as though it were one or the other, and his design should be so drawn as to show his ability as an architect, and that he was equal to any occasion where either the one or the other kind of material was obtainable or desired.

Architects prefer no doubt the brick-work, for if well and handsomely carried out it shows greater ability, but at the same time if thus carried out is very costly, as it involves specially-made moulded bricks, strings, ornaments, &c., for which many clients cannot afford to pay, whereas a building might be erected at same cost and treated the other way and even have certain well executed embellishments.

I can refer to the statue at the Australian Mutual Life Assurance Office in Hobart, which is excellent, in Portland cement, and also the coat of arms in the tympanum of the pediment at the Custom House, Launceston. This last work is in bas-relief, and is about 30 feet long by 8 feet high; both of these works are well executed and do great credit to the moulder.

Should any of the Members visit Launceston I would recommend them to observe the cement-coated buildings in St. John's-street, the careful manner they have been carried out, the good design, and the way they are grouped; any man who could see nothing good in them would, in my opinion, be a very discontented one; at the same time they should observe the brick buildings around same, and they will be found equally as good.

In carrying out brick buildings the bond should be particularly attended to; the supervising officer should not only see that the face is correct, but that the filling in and crossing of joints in same is attended to, for I have often seen a header put in with half a brick, it being nearest the bricklayer to pick up, and as the face has the proper appearance little notice is taken; but this should not be; the bond, and the keeping of

the work up to the line should be strictly attended to, or otherwise the building is no better than a building slummed and then covered with Portland cement to hide defects; in fact it is a sham bad work representing good.

Tuck-pointing I see no objection to, providing it is properly done. In many cases it is good work, and I will tell you why: if brick-work is carried out with a neat struck joint, to ensure good work it is necessary to do same as work proceeds, before the mortar is dry, otherwise the joints would not last the time. This method of striking the joints with a trowel or jointer brings the line forward, and forms in a short time a skin or crust, and prevents the inner parts of the mortar beds and joints from drying. In tuck-pointing it is necessary to roughly rake out the joints at the time of laying the bricks, which leaves the pores open and greatly assists in hardening the interior mortar, and, as it is left until near the completion of the building, gives the same an opportunity of hardening. I have known and can show several cases where, if the outside crust or skin is broken, the mortar can be taken out with a very slight friction as dust. Again, in making alterations to Public Buildings in Hobart, built in the early days with stone walls 30 inches thick, the face work has been made with what in the terms of the trade are called "shiners," and the inside has been filled up with what I call rubbish, and the mortar has come away almost like dry sand: now if this is done with good face brick-work it is no better than rough brick-work faced over with Portland cement compo, and although good brick-work should show for itself, it is no safer than the work I have described. I do not say this to justify using Portland cement compo, but to show that both brick-work facing and works faced Portland cement compo are subject, or may be, to the same abuse.

In tuck-pointing the bricks should not be coloured, only with sufficient stopping to satisfy the joints, and then the white line should be struck. The colouring of the bricks makes the work like a painted doll's house, and is monotonous in appearance, but let the bricks remain their own natural colour the effect is enhanced in value. Tuck-pointing is good if properly carried out, and the white line will last a lifetime, and even should the white line come off, the pointing by the stopping is equal to any ordinary pointing by trowel or jointer.

Unless the work is properly supervised the tuck-pointers will make false joints to make work look even; this is a

falsehood; the work, whether Flemish or English or any other bond, should be so set out that there should be no occasion for false joints. This will especially apply to gauged jack arches, to door and window openings.

I think we should look back to the work the Romans and Normans did in their time, but only as examples to improve upon; we should also look forward for the proper use of new material that from time to time will come to our hands—this is a progressive world and we must still go on. Hundreds of years ago brick walls were covered with compositions, and Portland cement is really (on exteriors) taking the place of such coatings.

In large towns I think a good effect is given, especially where the streets are very long, by a combination of material being used, either in one building, or a separate material for each, for nothing wearies the eye more than to see all buildings the same.

Again, referring to the pointing of brickwork with the trowel, it is frequently done upside down—*i.e.*, the joints are undercut instead of over-cut or weathered. This mistake causes the rain-water to lie on top of the joint and also to lead same to the bed of the joint.

Exceptions are taken to lining out Portland cement fronts to represent blocks of stone, but surely anyone can tell a Portland cement front from stone, unless painted, and then it is a matter of indifference of what material it may be; there is no more disguise in it than a man having his passage papered with marble paper and lined out, or an enamelled slate mantel-piece, for the difference can always be told.

I would advise all architects, and especially young architects, to be not afraid to express their opinion, and not to proceed to design a building in any material (simply to carry out his client's wishes) until he has properly advised him and pointed out clearly all his reasons why he would recommend a certain material in preference to others; but if after pointing out the differences the client still persists in his wishes, then the architect can honestly proceed with the work. The architect, in advising his client, should show clearly every reason for his recommendation of such a site, surroundings, back-grounds, materials most easily available, including difference in cost, the effect of certain weather, &c., and to be thoroughly honest in every particular to his client and also to his builder, foreman, and clerk of works, but first of all to himself, for without that he cannot be honest to the others; but I am afraid that com-

petition sometimes interferes, and the £ *s. d.* is only considered.

I should have mentioned ere coming so near to the end of my paper, that the Romanesque and Free Classic are good orders of architecture for the employment of Portland cement where it is necessary to use the same, and I am convinced it is a good material to use, if desirable, under the circumstances hereinbefore mentioned; not that I prefer Portland cement fronts to brick or other material, but circumstances must guide the way. When used, the cement should be taken out of the casks sufficient for a certain front and laid out on dry boards in a dry place for from four to seven days for tempering, and the whole thoroughly mixed together dry so as to ensure one chemical action throughout to prevent blowing or difference in colour upon face of the work. The rendering should be perfectly dry before the setting coat is put on, as it gives an opportunity for any defect in the greater bulk to settle down ere finishing.

Architects should not object to expressions of opinion by laymen, but listen and say nothing. Some information may be obtained. At times it often occurs, as Mathew Prior the poet says, "He who speaks the most has the least to say," therefore architects may often have to listen to more than is necessary.

One thing also must not be overlooked, and that is the wealth of the client, which bears much upon the subject of materials. To briefly draw attention to same: a man of wealth might have a palace of marble instead of stone, with columns of granite, with capitals of alabaster instead of Parian or Keene's cement and so on, but the difference of appearance would not be so great as the difference in cost; but it would show wealth, and wealth and taste should go hand in hand.

Many handsome buildings have been finished in Portland cement; take London, Brighton, Eastbourne, and Worthing, in England: there the manner of treating the buildings with cement has been carefully done. I may add, as time advances many other materials besides those now in use may crop up which we will have to mould to suit the times and circumstances.

Not only should the materials be considered, but so should the supervision in either the overlooking of cement and brickwork, for much good material and labour has been wasted for the want of a thorough knowledge of the same.

My paper is only a short one giving a few practical hints,

but do not think I have written this to praise Portland cement buildings in preference to other materials, but I have written this paper more to show that all materials should be taken fully into consideration and to be used according to circumstances requiring them; for I consider all materials equal if used in a proper manner and in their proper places. And where good stone, white or red bricks are to be obtained, I say use them, but if only of an inferior quality, cement would be better; if in cement, the work underneath should be carried out in a workmanlike manner, leaving the faces rough for a good key to take cement.

ADDENDUM

TO

Section D.—Biology.

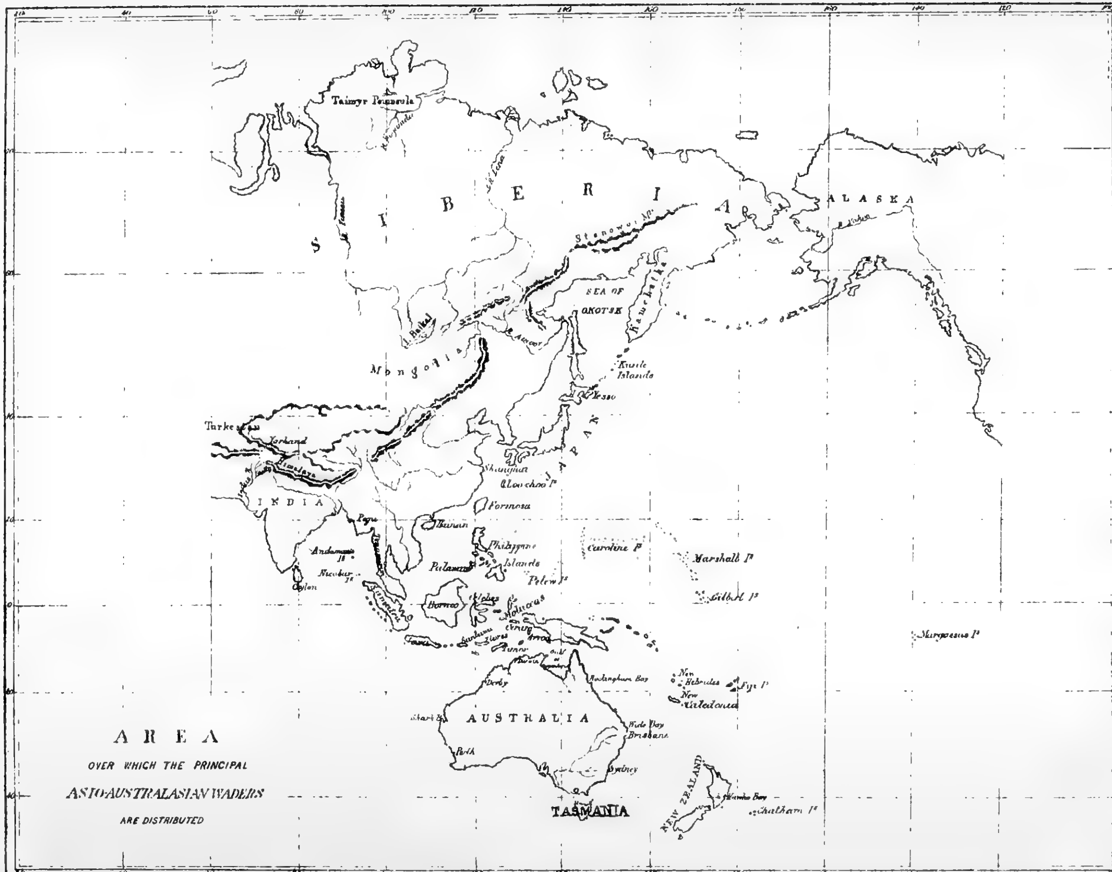
16.—ON THE GEOGRAPHICAL DISTRIBUTION OF THE AUSTRALIAN *LIMICOLÆ*.

By Lt.-Colonel LEGGE, F.Z.S., M.B.O.U., late F.L.S., C.M.A.O.U., &c.

THE *Limicolæ*, or so-called "Waders" and shore birds, are perhaps the most interesting members of our avi-fauna. The Sand-pipers and Shore-plovers, which form the bulk of this order, are elegant and graceful birds, and in addition to these personal characteristics they number in their ranks species whose great wing-power has developed in them to the highest extent a wandering nature and a persistent propensity for roaming over vast expanses of our globe, which cannot fail to excite interest in all who love bird-life. Combined with these traits is the wonderful instinct of migration, which annually sends them southwards from their northern breeding-grounds, and locates them for a season on our coasts, until it again drives them back to rear their young once more in the north.

Among the Shore-birds of Australia are to be found the greatest roamers of the family, such as the Grey Plover, the Turnstone, the Curlew Stint, the Whimbrel, the Knot, and several other species, whose annual arrival or casual occurrence on our coasts is always looked forward to by Australian naturalists. This wandering propensity is, however, not possessed by all the Australian members of this family, for, as will be seen in the course of my remarks, there are not a few species which are resident in our region; while the summer or breeding habitat of several others is confined to Eastern Asia, from which they migrate in their winter season to Australia and Polynesia. In reference to the terms "*summer*" and "*winter*" as applied to Australian shore-migrants, it may be well here to remark that as they breed in the other hemisphere during the northern summer, they come to us for the purpose of "wintering" during our southern summer.

A glance at the map of the globe will serve to exemplify the migratory movements of the *Limicolæ*. Observation proves that, like other birds which prior to the Glacial epoch were resident in the Arctic regions, and now only resort


SIBERIA
ALASKA
Taimyr Peninsula
SEA OF OKOTSK
Kamchatka
Kurile Islands
Yesso
JAPAN
Mongolia
Turkestan
Yarkand
Himalaya
INDIA
Ceylon
Andaman Is
Nicobar Is
Pegu
Hainan
Formosa
Shanghai
Loochoo Is
Philippine Islands
Palawan
Pelew Is
Caroline Is
Marshall Is
Gilbert Is
Marquesas Is
Borneo
Celebes
Moluccas
Sumatra
Java
Timor
AUSTRALIA
Derby
Perth
Rockingham Bay
Wide Bay
Brisbane
Sydney
TASMANIA
New Hebrides
New Caledonia
Fiji Is
NEW ZEALAND
Chatham Is
AREA
OVER WHICH THE PRINCIPAL
ASIO-AUSTRALASIAN WADERS
ARE DISTRIBUTED

thither to rear their young, the *Charadriidæ* and *Scolopacidæ* migrate pretty well due south of their own particular breeding grounds until they reach some territory which terminates their migratory path or else diverts them off to the east or west into contiguous regions. In other words, "Shore-plovers," or Sand-pipers which breed in the nearctic region migrate down the American coasts, some diverging off into the West Indies, others continuing onwards into South America; while other members of the same species which breed in the palæarctic region migrate—(1st) through Europe to the Mediterranean, and thence onwards into Africa, according as the migratory impulse is weak or strong; (2nd) through Asia southwards to India and Ceylon, which terminates their journey; (3rd) down the coast of China into the Malay Archipelago, and thence onward to Australia, a considerable diversion of the migratory stream taking place through the Philippines and the Papuan Islands into Oceania. Thus it will be understood that a Turnstone or Grey Plover breeding in Greenland or the Hudson's Bay territory, will winter in the West Indies or Mexico, while a Turnstone or Grey Plover breeding in N.E. Siberia will pass its winter season perhaps in Tasmania or in Fiji.

The number of species in this order inhabiting the Southern Hemisphere is smaller than in the Northern, owing to the comparatively small quantity of land available for their location after migration, and likewise the distance of the southern territory from their Arctic breeding-grounds. In England, for example, the *Limicoline* birds number forty-eight, some of which are American wanderers. In Ceylon, another small region, and which is also situated at the end of the migratory path of Asio-Indian migrants, the *Limicolæ* number forty-four species. Coming now to Australia, with its vast territory and lengthy coast line, we find only forty-six species resident in, or migratory to its shores, only twenty-one or -two of which fall to the share of Tasmania. Still further south is New Zealand, lying wide of the general migratory path, and conspicuous for the paucity of its species in spite of its great coast line. There the *Limicoline* birds only number twenty, six being peculiar to the country.

Doubtless if an Antarctic continent with a climate as mild in its medium latitudes as the Arctic regions existed, we should have a far greater number of shore-migrants than are now included in our lists, and I may here remark that the existence of such a species as the Double-banded Dotterel,

which goes down to New Zealand to breed, as well as that of one or two resident forms, such as the Black Stilt and a Shore-plover, indicate the probability that in former ages there have been Antarctic breeding-grounds, these forms being the remnant of breeders in that region prior to the Glacial epoch.

In tracing out the geographical distribution of the Australian *Limicolæ*, I shall first follow their migration to or from their Asiatic summer habitat, and then deal with their westerly range in Europe and Africa, glancing finally at the migration of such of our species as are found in the new world.

The classification adopted is that of my work on the "Birds of Ceylon," following which the *Limicolæ* of our region divide themselves as under :—

Family *Scolopacidæ :*

1. Rynchæa australis, *Gould.*
2. Gallinago australis, *Lath.*
3. Limosa uropygialis, *Gould.*
4. Limosa melanuroides, *Gould.*
5. Terekia cinerea, *Güld.*
6. Totanus incanus, *Gmelin.*
7. Totanus glottis, *Linn.*
8. Totanus stagnatilis, *Bechst.*
9. Tringoides hypoleucos, *Linn.*
10. Bartramia longicauda, *Bechst.*
11. Tringa acuminata, *Horsf.*
12. Tringa crassirostris, *Schlegel.*
13. Tringa canutus, *Linn.*
14. Tringa subarquata, *Gmelin.*
15. Tringa ruficollis, *Pallas.*
16. Strepsilas interpres, *Linn.*
17. Numenius cyanopus, *Vieill.*
18. Numenius phæopus, *Linn.*
19. Numenius minor, *Müller.*

Family *Charadriidæ :*

20. Recurvirostra novæ hollandiæ, *Vieill.*
21. Himantopus pectoralis, *Dubus.*
22. Himantopus leucocephalus, *Gould.*
23. Himantopus novæ zealandiæ, *Gould.*
24. Squatarola helvetica, *Linn.*
25. Charadrius fulvus, *Gmelin.*
26. Eudromias australis, *Gould.*

27. Eudromias veredus, *Gould.*
28. Ægialitis geoffroyi, *Wagler.*
29. Ægialitis mongolica, *Pallas.*
30. Ægialitis mastersi, *Ramsay.*
31. Ægialitis bicincta, *Jard. & Selb*
32. Ægialitis monacha, *Geoff.*
33. Ægialitis nigrifrons, *Cuv.*
34. Ægialitis ruficapilla, *Temm.*
35. Ægialitis hiaticula, *Linn.*
(?) Ægialitis jerdoni, *Legge.*
36. Erythrogonys cinctus, *Gould.*
37. Lobivanellus lobatus, *Lath.*
38. Lobivanellus miles, *Bodd.*
39. Sarciophorus pectoralis, *Cuv.*

Family *Œdicnemidæ:*
40. Esacus magnirostris, *Geoff.*
41. Œdicnemus grallarius, *Lath.*

Family *Glareolidæ:*
42. Glareola grallaria, *Temm.*
43. Glareola orientalis, *Leach.*

Family *Hæmatopodidæ:*
44. Hæmatopus longirostris, *Vieill.*
45. Hæmatopus unicolor, *Wagler.*
46. Hæmatopus ophthalmicus, *Castl. & Rams.*

In the above list *Æ. jerdoni* (mihi) is inserted on Dr. Ramsay's authority, who, however, only doubtfully includes it in our avi-fauna as a species from New Guinea not yet properly identified. Being found on the Papuan south coast entitles it to a place among Australasian birds.

Fam. Scolopacidæ.

1. Rhynchæa australis.

(Australian Painted Snipe).

Rynchœa australis, Gould, P.Z.S., pt. 5, p. 155; Ramsay, List Austr. B., p. 20, (1888).

This handsome bird, which forms a link between the Snipes and some members of the Rail family, was considered by Gould to be a summer visitant to New South Wales, and is recorded by him as plentiful in the Upper Hunter district. Dr. Ramsay notes its most northern locality as Rockingham

Bay, on the Queensland coast, whence it spreads southwards down to Victoria, where I have myself shot it in the summer months. Westwards from Victoria it is found in South Australia and West Australia, ranging far north into the interior.

The members of this genus are not migratory to any great extent, the near ally of our bird, the *Rynchæa* of Asia and Africa, being resident in the districts and localities it affects. It is probable, therefore, that the Australian *Rynchæa* is merely a local migrant, moving northwards in the winter season. If a migration to the *far* north took place the species would have ere this been recorded from the north coast,—a district, moreover, in which one would expect to find it resident, the genus being decidedly a tropical one.

The Australian Painted Snipe has not yet been observed in Tasmania.

2. Gallinago australis.

(Australian Snipe).

Scolopax australis, Latham, Ind. Orn. Suppl., p. 64, (1790); Seebohm, *Ibis*, 1886, p. 133; Ramsay, List Austr. B., p. 20, (1880).

Although the Snipe on passage to its "winter" quarters in Australia passes over much latitude, its path is very restricted, as it does not touch the China coast on its flight from Japan to the north of Australia. Neither does it diverge into Polynesia nor wander eastwards from our coasts to New Zealand, which testifies to the narrowness of its migratory path. It breeds in both islands of Japan, where Swinhoe records it as being found at Hakodadi from June till August. Blakiston obtained it in Fujisan in June and July, and speaks of it as being abundant in Yezo, where the Japanese name for it is "Yama-shija." It passes over the Philippine group in migration, as it has recently been obtained on the island of Palawan, and I observe that Mr. Sharpe in his list of the birds of that island (*Ibis*, 1888), gives the species a Bornean and Philippine habitat, although I have not seen it recorded from Borneo. On arrival in Australia in September and October it apparently diverts in limited numbers only to the westward, as Dr. Ramsay records it from Derby (Kimberley district), but not from anywhere on the north coast proper. The great stream of migration takes place down the eastern side of the continent, whence the bird passes into the interior and through Riverina to Victoria, and thence westward to

Southern and Western Australia, in most of which colonies it is common. In Tasmania it has always been numerous in certain localities, although since many of its haunts have been drained it has become less plentiful during the last ten or fifteen years. Careful observations on its arrival in and departure from this island, which is the southernmost limit of its range, would be highly interesting. Individuals arrive here from the north as early as August, but the bulk of our visitants only reach our shores towards the latter end of September. Immature non-migratory birds occasionally have been observed in the winter months in Tasmania, but this is common to many of the highly migratory *Limicolæ*.

The Snipe is perhaps nowhere more abundant than in the marshy districts bordering the Murray on its course through Riverina.

3. Limosa novæ-zealandiæ.

(Barred-rumped Godwit).

Limosa novæ-zealandiæ, Gray, Voy. *Erebus* and *Terror*, p. 13, Birds, (1884); Buller, Birds of N.Z., vol. ii., 2nd ed., p. 40, (1888).
Limosa uropygialis, Gray, P.Z.S., p. 38, (1848); Ramsay, List Austr. B., p. 20, (1888).

This Godwit is an eastern race of the European and Eastern-Asian Bar-tailed Godwit, *L. lapponica*, Linn. According to Von Middendorff it breeds in Amoorland and Eastern Siberia, in which regions this naturalist found it abundant from June till August. It however wanders further north than this, being found in the summer in Kamtskhatka and on the shores of the sea of Okhotsk, and has occurred on Behring Island, while individuals have wandered as far as Alaska, where the eggs were taken in 1868. It is found in the north island of Japan, and also in the south, being recorded by Blakiston from Yezo and Tokio. On passage it visits the China coast and the island of Formosa, where it has been obtained in April and September. During migration it is also found in Java, Borneo, Timor, Celebes, and other islands of the Archipelago; and in the southern summer it inhabits New Caledonia, the Solomons, New Britain, New Hebrides, the Loyalty Islands, and Fiji. It is dispersed round the Australian coasts, being recorded by Dr. Ramsay from Port Darwin round the north coast to Queensland, and thence southward to Victoria and South Australia, its range terminating in West Australia, northward of which it has probably up to this time been overlooked. In Tas-

mania Gould found it abundant at Pittwater, and I have obtained it in the month of November in Ralph's Bay. It affects suitable localities where there are tidal mud flats on our coast, and inhabits the Straits Islands as well. It is found in New Zealand, from which colony it departs, according to Buller, in April; this district and the Fiji group appear to form the limit of its range to the eastward.

4. Limosa melanuroides.

(Eastern Black-tailed Godwit).

Limosa melanuroides, Gould, P.Z.S., pt. 14, p. 84; Ramsay, List Austr. B., p. 20, (1888).

This Godwit, doubtfully distinct from the European and Western Asiatic species *L. Ægocephala*, Linn., does not appear to range so far south as the last species during its annual migration. Gould records it as having first been seen on the Australian coasts at Port Essington, and apparently described his type from among the specimens sent to him by Mr. Gilbert. Blyth, however, writing in the *Ibis*, 1865, and speaking as if he had examined the type, says he considers it only a small male of *L. ægocephala*, and that examples of that size may be procured abundantly in Bengal. Lord Tweedale records one individual from Negros (Philippines) as *L. ægocephala*, and therefore it is hard for me to define the distribution of the so-called Australian species unless I take all the Black-tailed Godwits from Eastern Asiatic coasts and the Malay Archipelago to be one and the same with our bird, and for the purposes of this paper I cannot well do otherwise. It is not improbable, however, that a comparison of an extensive series of examples from Western and Eastern Asia would lead to their union. Size is a weak characteristic in this genus, as Godwits shot out of the same flock vary in a most marked manner in this respect.

This Godwit is found in the summer on the shores of the sea of Okhotsk and in the North Island of Japan, in which region it probably breeds. On passage to and from the Northern Hemisphere it visits the coasts of China, where Swinhoe obtained it in the month of April. It occurs likewise in the Philippines, and Dr. Finsch records it from New Britain and the Gilbert Islands, which lie to the north-east of that Island. On the Australian coasts Dr. Ramsay notes it from Cape York and New South Wales, south of which colony it does not yet appear to have been observed.

5. Terekia cinerea.

(Avocet Sandpiper).

Scolopax cinerea, Güld., N. Comm. Acad. Sci. Imp. Petrop., xix., p. 473, (1774).

Tringa cinerea, Ramsay, List Austr. B., p. 20, (1888).

This curious Sandpiper breeds in Northern Asia and Europe as also on the River Terek (Caspian Sea), and is a cold weather visitant from North Asia to India, Malayana, and the northern parts of Australia. Mr. Seebohm found it abundant in the breeding season on the Yenesay, as far north as lat. 70°. Dr. Finsch procured it in Kara Bay in July; Schrenk obtained it on the Amoor, and Von Middendorf on the coasts of the Sea of Okhotsk; it doubtless, therefore, breeds throughout all the western portion of Siberia. From this region it passes in the winter season southward to Northern India, where it is abundant, and wanders thence through Tennasserim, Ceylon, the Andaman Islands, and Malay Peninsula to Java, Sumatra, and Borneo, but I do not find it recorded from either the Philippines or Celebes. It likewise passes down the coasts of China to the Malay Archipelago, and thence onward to Australia. Dr. Ramsay records it from the Wide Bay District, and Gould obtained his example on the River Mokai, New South Wales, in July, its breeding season. It follows, therefore, that this bird must have been a barren or non-migratory individual. Messrs. Sharpe and Dresser, in their "Birds of Europe," record its occurrence in Tasmania, but no recent testimony of its visiting the shores of this colony is obtainable.

In Eastern Europe it has been met with in large numbers on the islands near Archangel and on the Petchora, but it does not appear to range to the western part of the continent, not having been found in Great Britain or in Spain, although it has occurred in France, and on passage to the south it has been obtained in Italy. It passes through Western Asia to the Persian Gulf and Arabia, and strays rarely down the East coast of Africa to Natal and Madagascar, notwithstanding that it appears to avoid Egypt.

The peculiarity of this bird's migratory habit is that it avoids the western shores of the continents of Europe and Africa, and seems to centre itself in Northern India in the winter, being comparatively infrequent to the east and west of that region, wandering nevertheless in small numbers very far south. It is one of our rarest Australian visitants.

6. Totanus incanus.

(Grey Sandpiper).

Scolopax incana, Gmelin, Sys. Nat. 1, p. 658, (1788).
Gambetta pulverulentus (Müll.), Gould, Handb. Birds of Austr., ii., p. 208, (1865).
Totanus incanus, Ramsay, List Austr. Birds, p. 20, (1888).

This Sandpiper is a denizen of the coasts of Eastern Asia and Oceanica as far east as the Marquesas Group, where it has been obtained in winter plumage. It occurs in the north of Japan in May, and is common in spring and autumn in Yezo, breeding probably in these localities. According to Schlegel it is found on the coasts of the North Pacific. It passes on migration into the Loochoo Islands, the Philippine Archipelago (being found there from November to April), the islands of Borneo, Timor, Celebes, and New Guinea. Further eastward it has been procured in New Hanover, New Caledonia, Fiji, and the Navigator and Friendly Islands, and is probably found in the southern summer in many of the adjacent groups, but does not extend as far south as New Zealand.

In Australia Dr. Ramsay records it from Ports Darwin and Essington, the Gulf of Carpentaria, Cape York, the Queensland coasts, and New South Wales, south of which colony it does not seem to have been observed. Gould, who speaks of it as being abundant at Port Essington, is not precise as to the season of the year it affects that locality, though he describes the summer plumage from specimens procured there. It is not improbable that these may have been April birds, at which time it has been shot in Leyte (Philippines), in breeding dress. There seems as yet to be no record of its occurrence on the west coasts of Australia, but as it has been procured in Timor and the port just named, it will doubtless be some day procured in the Derby District and other places on the yet unexplored coast of that part of the continent.

7. Totanus glottis.

(Greenshank).

Scolopax glottis, Linn., Sys. Nat. i., p. 245, (1766).
Glottis glottoides (Vg.), Gould, B. of Austr. vi., pl. 36, (1828).
Totanus canescens (Gmelin), Ramsay, List Austr. B., p. 20, (1888).

This fine sandpiper is widely distributed over the face of the globe, being found along the coasts of the three continents of the Old World, while in America it is a straggler as far south as Chili. As regards Asia, it migrates from southern latitudes in the breeding season as far north as the

Stanowoi Mountains in Eastern Siberia, and passes south over Central Asia in the month of August, following likewise the coasts of China and ranging into Japan and the Kurile Islands. It continues its migration from China through Formosa, Borneo, Celebes, and other Malayan islands to Australia. More westerly streams of migration set in through Central Asia and Turkestan towards India, throughout which empire and the adjoining islands it is common in the cool season. In Ceylon I found that many individuals (non-breeding) remained throughout the year. In Australia Gould obtained specimens from every colony, and remarks that it is generally dispersed over the continent. Dr. Ramsay records it from Port Darwin, Cape York, the Gulf of Carpentaria, and the Queensland coast. Thence it ranges southwards to Tasmania, where, however, so far as I can ascertain, it has not been recently met with. It wanders into the interior of Australia to some extent, and is to be found on the flooded plains of some parts of the Murray districts during the spring. It has been met with in Norfolk Island. In western regions of the Old World it is found wintering in Palestine, whither it migrates from Western Siberia. In Europe it breeds in northern latitudes as far south as the Hebrides and parts of Scotland. In Central Europe it is a migrant, passing southward into Africa, and through Egypt down the coast to Cape Colony, visiting likewise the Seychelles and other islands in its course. Concerning its range in America, Mr. Saunders writes:—"Audubon obtained three specimens in Florida on the 28th May, 1882, and examples said to be from Buenos Ayres and Chili are in the Leyden Museum."

8. Totanus stagnatilis.

(Little Greenshank).

Totanus stagnatilis, Bechst. Orn. Taschenb., ii., p. 292, (1803); Gould, B. of Austr., vi., pl. 37, (1848); Ramsay, List Austr. B., p. 20, (1888).

The Little Greenshank, or "Marsh Sandpiper," though distributed over a wide area of the globe, has an uneven distribution, being abundant in many localities, as in India for instance, and absent from others contiguous to them. In Europe it has neither a westerly range nor a very northerly one, Lapland being the exception; and in Asia, unlike other widely-roaming *Limicolæ*, it does not appear to go far north, its breeding haunts being confined to Turkestan, and perhaps

the highlands of Yarkand and Southern Mongolia, though it has not been recorded from the latter region. Being, however, tolerably plentiful in parts of Burmah, it must necessarily migrate thither from some part of Mongolia.

It is nowhere more abundant than in parts of India and in Ceylon in the cool season, though it is rare in the Nicobars and in Tenasserim, but south of the latter country it becomes scarce, having been obtained only in some of the Malay Islands—Java, Borneo, and New Guinea ; and to Australia it can only be considered a straggler. It has been met with on the southern coasts of China and in Formosa, but not in the Philippines, nor does it range eastward into Polynesia or New Zealand. It is found in Western Asia, wintering in Palestine. In Europe it is chiefly confined to the central portions of the continent and Southern Russia, breeding in the latter country and in Hungary. It is rare in Western Europe, and has not been observed in England. In the islands of the Mediterranean it occurs on passage to Egypt, where it is most numerous on the Lower Nile. It has been obtained both in winter and in summer in the highlands of Abyssinia, and therefore breeds there, as Von Heughlin observed it in breeding plumage. It is likewise found on the west coast of Africa, and migrates to the south in winter, inhabiting Natal and other provinces.

As I have observed, it is a rare visitant to Australia in the northern winter. Gould procured it on the Mokai in 1830, and Dr. Ramsay records it from the Wide Bay District (Queensland) and the south coast of New Guinea.

9. TRINGOIDES HYPOLEUCOS.

(Common Sandpiper).

Tringa hypoleucos, Linn., Sys. Nat. i. p., 250, (1766).
Actitis hypoleucos, Gould, Handb. of Austr., ii., p. 263, (1863). Ramsay, List Austr. Birds, p. 20, (1888).

This interesting sandpiper, known commonly in England as the "Summer Snipe," is, so far as the Old World is concerned, one of the most cosmopolitan species of its family. From the sands of the sea coast and of bays and inlets up to an elevation of 17,000 feet, wherever there are lagoons, lakes, marshes, or broad rivers, this little bird is likely to be met with. Its Asiatic breeding haunts extend from the Himalayas and highlands on the north of this range, through Siberia to the arctic circle, and stretch across the continent from Europe to Kamtschatka, taking in the Stanowoi mountains where

Middendorff met with it near the summit of the range. From Kamtschatka it crosses over to South Alaska, but appears not to extend down the west coast of America. It is an abundant winter visitant to India, Ceylon, Burmah, the Malay Peninsula, and thence southwards through the islands of Malayana to Australia, round the whole coast of which continent it has been met with; in the interior, according to Dr. Ramsay, it has not been found, and to Tasmania* it is a rare straggler. It is singular that it has not been met with in New Zealand, but the wide expanse of ocean between New Caledonia and that colony probably militates against its migration thither.

Turning westward again we find the common sandpiper summering in Japan and China and found on passage in Formosa, the Philippines, the Pelew islands, the Solomons, the Gilbert Group, Fiji, and New Caledonia; and as time goes on it will probably be met with on the shores of every Polynesian Group which shall be carefully examined. It is spread throughout Europe as a summer visitant, extending to the northern coasts of Russia. It is common in Great Britain, breeding there; I have taken its eggs myself in the highlands of Wales. It generally leaves England in September, and those birds which quit western Europe must form the migratory stream which passes down the west coast of Africa, taking in the Canary Islands, Maderia, and Teneriffe. In Eastern Africa it is found in Egypt, being a resident there as well as in Abyssinia. Southward it extends to the Transvaal and Cape Colony, and diverts to the Seychelles, Mauritius, and Madagascar, in all of which localities it is a "southern summer" visitant. Finally, in the New World it has been observed in South Greenland, but does not occur on the east coast of the continent, though found in the extreme north-west of it, as above observed.

10. Bartramia longicauda.

(Bartram's Sandpiper.)

Tringa longicauda, Bechst. Kurze nebersicht aller bekannten Vogel, p. 453, (1811).

Actitिturus bartramius (Wilson), Gould, Handb. B. Austr., ii., p. 242, (1863).

Bartramia longicauda (Bechst.), Saunders, Yarr, British B. iii., p. 440, (1882-4).

Actititurus longicauda, Ramsay, List Austr. B., p. 20, (1888.)

This fine American Sandpiper, which inhabits the New World from Alaska to Chili, is an extraordinary wanderer

* Accidentally omitted from my List of Tasmanian Birds.

from its usual habitat, appearing at considerable intervals in parts of Europe, and though avoiding notice on the continent of Asia, actually appearing rarely in Australia.

In the summer season it inhabits the Nearctic region for breeding purposes, being well known, writes Mr. Saunders, *loc. cit.* in Canada and Nova Scotia and "generally distributed during the summer over the northern and central portions of the United States to Illinois and Pennsylvania. It is especially abundant on the great plains on the eastern side of the Rocky Mountains, where it is called the 'Prairie Pigeon,' but as yet it is not known to cross that natural barrier, though it has been found so near as the Big Blue River, Utah; and in the north west it was obtained by Mr. Dall on the Yukon River, Alaska." Its spring migration takes place largely through the western States of America, the birds returning southwards in the month of August, and passing through Mexico and Central America to Colombia and Brazil, and thence onward into Eastern Peru and Chili. It likewise diverges in considerable numbers to Bermuda and the West Indies. The occurrence of seven examples is recorded by Mr. Saunders to have taken place in Great Britain, some in western, and others in north-eastern countries. In the same sporadic manner it has been met with in parts of Europe, viz., Sweden, Holland, Germany, and Italy, as also in Malta; but in the two latter localities only has it apparently been properly identified.

In Australia Gould recorded it from New South Wales on the testimony afforded by an example shot in the snipe season of 1848, near Sydney. Dr. Ramsay, however, notes it from Wide Bay and from the interior, where the late Mr. K. H. Bennett met with it in the Bourke district. The late Count Castelnau, Dr. Ramsay informs me, also procured an example in the Melbourne market.

11. Tringa acuminata.

(Marsh Stint).

Totanus acuminatus, Horsf., Tr. L. Soc., xiii., p. 192, (1821), Java.
Limnocinclus acuminatus, Gould, Handb. B. of Austr., ii., p. 254, (1848).
Tringa acuminata, Ramsay, List Austr. B., p. 20, (1888).

This Stint is an Oriental migrant, with normally a narrow migratory path. It was first described from Java by Horsfield, who no doubt procured it while it was on passage to or from the China coast. In summer it is found on the north

coast of China, where Swinhoe noticed it as abundant in the month of August. It is likewise found at that time of the year on both islands of Japan, where it probably breeds. On passage to and from its summer haunts it occurs in the Philippines, where it has been shot in the month of May in nuptial plumage, and also in other islands of the Malay Archipelago, in some of which it may possibly breed, as it has been shot in Celebes in July. In regard to our own region, it extends round the west coast of Australia, having been observed at Derby on the north-west, as well as in other northern, eastern, and southern districts. Dr. Ramsay likewise records it from the interior. To Tasmania it is an occasional visitant, specimens being existent in the Hobart Museum.

Returning to its distribution in Asia, it does not seem to extend inland to the west, except as a very rare straggler, to the Indian region, where in August, 1880, Major Biddulph shot a male in adult plumage at Gilgit, which lies at the base of the Hindookoosh Mountains. This is one of the most remarkable instances on record of a migratory bird straying from its usual path, as the locality in question would seem to have been reached by it in the course of long wandering up the rivers of China to the region north of the Himalayas, and thence across the great range to the upper waters of the Indus.

The Marsh Stint appears to have no Polynesian range, nor is it found in New Caledonia or New Zealand.

12. Tringa crassirostris.

(Great Stint).

Tringa crassirostris, Schlegel, Fauna, Jap. *Aves*, p. 107, pl., 64, (1846), Ramsay, List Austr. B., p. 20, (1888).
Shœniclus magnus, Gould, P.Z.S., 1848, p. 39.
Tringa tenuirostris (Horsf.), Gould, Handb. B. of Austr., ii., p. 260, (1865).

This Stint, the largest of its genus, may be said to take the place of the Knot in Eastern Asia, and has been styled by some naturalists the "Chinese Knot." It has been traced as far north as the Amoor River and the shores of the sea of Okhotsk, and is also found in the summer in both islands of Japan. From this region it was first described by Schlegel in his "Fauna Japonica." On passage down the Chinese coasts it is tolerably plentiful, and Swinhoe found it in partial summer plumage at Shanghai in the month of April, proving

that it is an early migrant to the North. As in the case of the Knot, it has not yet been observed in the Philippines, but has nevertheless occurred in Java and Borneo, and is noted in Dr. Ramsay's list from New Guinea. It is found along the north coast of Australia, and is also recorded from Rockingham and Wide Bays as well as from the coast of New South Wales, but does not seem to have been met with either in Victoria or South Australia, though it finds a place among the birds of West Australia.

Returning to Asia we have the remarkable fact that of late years this species has been found as far west as Kurrachee Harbour (Sindh) where Mr. A. O. Hume, the indefatigable Indian Ornithologist procured it in February, 1871. It was common there in that month and was also observed at Gwader. Subsequently it was procured at Port Blair, on the Andaman, by Captain Wardlaw Ramsay, in January, 1872; these three localities being the only places in the Indian Empire where it has been met with. Its occurrence on the west coast of India, not as a straggler, but in considerable numbers in company with other cold-weather visitants to the country, indicates the probability of the existence of some Central-Asian or Mongolian breeding-place from which these birds had migrated southwards *via* Turkestan, and is a most interesting point in the history of the species. The Andaman Island birds spoken of were probably outliers in that particular season from the migatory stream down the China coast to the Malay Archipelago, and their location there is not nearly so remarkable as that of their fellows in Sindh.

13. Tringa canutus.

(Knot.)

Tringa canutus, Linn, Sys. Nat., Ed. 2, p. 251, (1776); Gould, Handb. B. of Austr., ii., p. 259, (1865); Ramsay, List Austr. B., p. 20, (1888).

The occurrence of the Knot in Australia is another instance of a western species wandering far wide of its usual migratory path. It is recorded by Gould as having been first shot at Moreton Bay in the month of September, and subsequently Dr. Ramsay has entered it in the Victorian and South Australian lists. Again, strangely enough, it has, according to Buller, occurred in both islands of New Zealand. In view of the fact that this species is very rare in India and has not been recorded from the Malay Archipelago, while on the other hand it has been met with on the north coast of China

and in Japan, the inference concerning the visits of the Knot to the Australian region probably is, that it avoids an inland migratory path from the far North, southward over the Asiatic continent, and wanders as a comparative straggler from its easternmost breeding-place in Siberia down the east coast of Asia to Australia, passing probably over the Philippines and New Guinea, where up to this time its presence has been overlooked. As regards its location in Siberia in the breeding season, Von Middendorff found a solitary example dead in the Taimyr Peninsula, and it has also been procured on the Amoor and in Dauria, so that there is, without doubt, as remarked above, a small migratory stream through Eastern Siberia towards the south. Turning to the west we find the Knot more common in European and American Arctic regions during the summer than it is in Siberia. Mr. Saunders, in "Yarrell's British Birds," writes of it as common in the British Isles and Western Europe during migration, though less plentiful eastward of the Baltic. It passes through Spain on passage to the south and wanders down the west coast of Africa as far as Damara Land. In eastern Europe, as might be expected therefore, it is less common, being rare on the Black Sea, but some individuals find their way along the east coast of Africa, and have been found as far inland as the Blue Nile.

During the month of May it occurs in abundance in Iceland, and is likewise a visitor in summer to South Greenland, but further west its range extends to the extreme North, for Sabine found it breeding in Melville Sound in 1820, and during an expedition of the "*Alert*" and "*Discovery*" Major H. M. Fielden met with this species in several localities, notably in Grinnell Land (lat. 81° 44′) and also at Discovery Bay. At the former locality it was numerous, and newly-hatched birds were procured by Mr. H. C. Hart, of the *Alert*, but no eggs found. Its eggs have however since been obtained by Lieut. Greely, A.S.N., who commanded the expedition to Lady Franklin Sound, the locality being Fort Conger (lat. 81° 44′). It has likewise been said to breed farther south on Hudson's Bay. Westward along the Arctic circle of the New World it has been obtained at Point Barrow, on the north coast of Alaska, and also on the west coast of that country at the mouth of the Yukon. During migration it passes down the continent, through Canada and the United States, and wanders as far south as Brazil, where it was obtained by Prince Maximilian.

14. Tringa subarquata.

(Curlew Stint).

Scolopax subarquata, Güldenstadt, Nov. Comm., Petrop., xix., p. 471, (1775).

Ancylochilus subarquatus, (Gmel.), Gould, Handb. B. of Austr., ii., p. 256, (1865).

Tringa subarquata, (Güld.), Legge, B. of Ceylon, p. 879, (1880)*; Ramsay, List Austr. B., p. 20, (1888).

This fine Stint is a bird which always maintains its interest for the ornithologist, owing to its nest and eggs still being unknown, a fact rendered all the more curious by the very short space of time which it evidently spends on its unknown breeding-grounds in the Arctic regions. For a short time in the breeding season the Curlew Sandpiper is found in the Arctic Circle of Siberia, following the larger rivers towards the north as far as lat. 74°, at which point Von Middendorf met with it on the Taimyr river, in the Peninsula of that name. As late as the month of May it has been procured while on passage up the coast of China in breeding plumage. It appears to wander north *via* the shores of the Sea of Okhotsk and the coast of Kamtschatka to Behring Straits, but apparently avoids Japan, as, singularly enough, it has not yet been recorded from that locality. It is found in Formosa while on passage, but has not been met with in the Philippines nor in many other of the islands of the Archipelago. It has been obtained at Singapore and in Java and Borneo, halting likewise on the coast of New Guinea while on passage to North Australia. It is generally dispersed along the shores of this continent, although there are some localities, such as Derby on the north-west, and Rockingham Bay and Port Denison on the east coasts, where it is not recorded from. Mr. Campbell writes me, however, that he met with it in December on the Houtmans Abrolhos islands. In Tasmania it is met with not uncommonly on the north and north-west coasts, where Messrs. Atkinson and Holden have both procured it. Farther east than Tasmania it does not appear to range, not having been as yet observed in New Zealand or New Caledonia, and it has no Polynesian distribution, a singular

* The geographical distribution of this and other species comprised in this notice is exhaustively worked out in my "Birds of Ceylon," but I do not transcribe it here, as it is advisable in dealing with Australia to follow out the distribution of our species in a slightly different order.

fact when we consider its wide range in other parts of the globe.

Returning to Asia we find that the Curlew Stint is a cold-weather visitant to India, Burmah, Tenasserim, the Andaman Islands, and Ceylon, in which latter island I usually observed it, first arriving about the end of September and departing again in April. Numerous examples, however, remain throughout the summer season in that island, most of them being in the premature stage, although I have seen individuals during the month of July in partial breeding dress, these being probably second-year birds which had not yet arrived at the age for nesting. It is not uncommon in North West India, in Sindh, and on the Mekran coast, while on the Sambhur Lake it has been obtained by Mr. Adam, an Indian ornithologist, both during the months of May and August, in full breeding plumage. This singular fact may perhaps be explained by the May birds not having yet migrated, and the August examples having returned from their breeding haunts prior to moulting. It is however remarkable that Père David and Count Prjevalsky met with this species in Mongolia and in the Hoangho Valley in summer, while another naturalist and traveller, Dr. Henderson, found it common near Yarkhand in the month of August, all of which circumstances, in conjunction with Swinhoe's observations in China and my own in Ceylon, go to prove that this species, which migrates down the Siberian rivers to the Arctic circle during the summer months, either remains a very short time on its breeding grounds, returning before moulting, or else breeds at irregular dates during the season, some examples even nesting in undiscovered Central Asian localities. Further west it is found during the spring months on the Caspian and in Europe, where it is widely dispersed; there is a general migration in the spring from the southern parts of the continent to the extreme north, and a return movement in the autumn, at which time this species is most common in England. In Northern Africa it is a spring and autumn migrant, passing down both coasts to Cape Colony, occurring likewise in Madeira on the west and in Madagascar on the east side of the Continent. It has been found in autumn, winter, and spring on the banks of the Nile, and has been met with in every littoral district in Africa that has been scientifically examined. Lastly, it occurs in Iceland in the summer, and is a straggler down the east coast of the New World as far as the United States.

15. Tringa ruficollis.

(Eastern Stint).

Tringa ruficollis, Pallas, Reis. Reichs., iii., p. 700, (1776).
Tringa albescens, Temm., pl. col. 41, fig. 2, (1824); Ramsay, List Austr. B., p. 20, (1888).
Actodromas australis, Gould, Handb. B. of Austr., ii., p. 257, (1865).

The correct identity of this little Stint is still a matter of doubt. The difference of opinion as to whether Pallas and Temminck were describing the same species or not, and the fact of a Stint said to be this species having bred at the Houtmans Abrolhos, render it somewhat difficult to determine what the Australian form really is. I do not attach much importance to the second difficulty, as we shall presently see that Arctic-breeding species, by some strange impulse, occasionally stay behind to nest in the Polynesian region. Some years ago I examined in the National collection at the British Museum and elsewhere in London, a large series of Asiatic Stints, and came to the conclusion that the eastern Asiatic and Australian form was referable to *Tringa ruficollis* of Pallas, and I may state that I was supported in this view by Mr. J. E. Harting, the specialist in this order of birds. Nevertheless, I am of opinion that a comparison should be made of a series of examples in breeding dress (if possible), shot on Australian coasts when on the point of migration, with a series procured in summer on the China coast-line before the question can be satisfactorily settled. Taking our Stint to be the same as the Eastern Asiatic species, its range extends from N.E. Siberia and Amoorland down the coasts of China and Japan to the Philippines and the Malay Archipelago, and thence southward to the Australian coasts, terminating in this Colony, in which it arrives in large flocks in September and October. It has been procured during the month of May in summer plumage in Hainan, and at Sarawak in Borneo. At Hakodadi (North Japan) it has been obtained in partial summer dress in autumn. It is found on the coasts of New Guinea and on the north coast of Australia, and likewise down both sides of the Continent during the Australian summer. Gould records it as breeding in the Houtmans Abrolhos in December, but since his time I find no evidence of its nesting on Australian shores, although Mr. Campbell writes me that he found it in large flocks in the same locality and on Rottnest Island during December. In Tasmania I have found it

abundant in Ralph's Bay in October, and Messrs. Atkinson and Holden record it as common in the north-west from September till March, frequenting also the Straits Islands in numbers at the same period. This Stint has not been observed in New Zealand, and it has no Polynesian range.

16. Strepsilas interpres.

(Turnstone).

Tringa interpres, Linn., Sys. Nat., i., p. 248, (1766).
Strepsilas interpres (Linn.), Gould, Handb. B. of Austr., ii., p. 269, (1865); Legge, Birds of Ceylon, p. 900, (1880–2); Ramsay, List Austr. B., p. 20, (1888).

This very interesting and handsome bird is the greatest nomad among the *Limicolæ*, and is perhaps the most cosmopolitan species on the face of the globe, being distributed along the coasts of the Old and New World, and over the shores of almost every island group in the universe. There is but one long stretch of coast from which it is absent, and on which, from Alaska to Mexico, its place is taken by its near ally, *S. melanocephala*. It is not, however, at all times a littoral bird, for on passage to and from its breeding haunts it has been found on the highlands of Yarkand, in Central Asia, and likewise on the shores of Lake Nyassa. In the breeding season the Turnstone has been met with along the western shores of the Nearctic and Palæarctic regions, viz., from Alaska to Greenland, and from Norway to Kamtschatka, including the islands of Nova Zembla and Spitzbergen. It breeds, however, so far south as the shores of the Baltic, and is supposed to have nested even in Shetland, the Western Isles of Scotland, and the Azores; but some doubt is thrown on this by recent authors. And in this connection it is well to remark that the Turnstone is a species which lingers behind in its winter quarters after partly assuming the breeding dress; it may be found thus attired in India, Ceylon, and even in Australia, so that it cannot positively be assumed on the evidence of plumage that it is breeding in any particular place.

In the early autumn a migration from the Arctic Circle sets in to the south, and the Turnstone passes down through Central Asia into Persia, India, Ceylon, the Malay Peninsula, and the islands of the Indian Ocean and the Bay of Bengal. At the same time other birds take a more easterly course, over Mongolia and down the coasts of China and Japan to Formosa, the Philippines, Malay Archipelago, and New

Guinea, and thence onwards to Australia, down both sides of which continent the species wanders to the termination of its course—Tasmania—many spreading eastwards to New Zealand. Again, a diversion of the migratory stream takes place eastwards from the coasts of China, and the Turnstone from that quarter passes, we may suppose, *viâ* the Loochoo Islands and the Pelews into America, over the whole of which region it spreads during the southern summer, being fouud as far off as the Marquesas and even the Galapagos Islands. Scarcely an island in Polynesia has been explored on whose shores it has not been found in the migratory season; and on Pleasant Island, an outlier of the Gilberts, it is, according to Dr. Finsch, kept in confinement for fighting purposes! As regards Australia, it is noted in Dr. Ramsay's "List" from all the ornithologically examined coast districts but Derby and Dawson's River. In Tasmania it is generally seen about the first week in October, being common, according to the testimony of Dr. Atkinson and Dr. Holden, during that month in the Circular Head District, and along the north-west coast generally; and the former gentleman informs me that he has occasionally seen stray birds during the winter season in that district. In the south I have met with it on the Actæon Islands in November, but there is no doubt that it is not generally distributed round our coast, and can only rank as an uncommon bird as far as most districts are concerned. In the more northern parts of Europe it is only found on passage, and the same is true of the Black Sea and many parts of the Mediterranean. In the northern districts of Great Britain it is chiefly a spring and autumn visitor, though it remains throughout the winter on the south coast and likewise in Holland. In Spain and Portugal it is likewise a spring and autumn migrant. In Tangier and Algeria it is a bird of passage, but on the coasts of the Red Sea Von Hueghlin met with it in May and July, and this naturalist made known the remarkable fact that it has bred in that region, he having met with young birds accompanied by their parents at Ras Belul in September. It has also been surmised that it may breed in the Canaries, as it has been noticed there all the year round. On migration to the Cape it diverts to Madagascar, and I believe it is found in the Mauritius. As regards its range in the New World, we find Major Fielden noticing it during the "*Alert*" and "*Discovery*" expedition as far north as Smith's Sound from June to September, and accompanied with young broods able to fly on the 12th August;

and beyond this locality towards the north he met with it as far as lat. 82° 30′ on the 12th September. Along the north coast of America it is found in summer as far west as Alaska. On the east coast of the Continent it is tolerably common on passage, and in north Carolina it remains throughout the winter. It visits Bermuda and is likewise found in Cuba, Jamaica, and other islands of the West Indies. In South America its distribution has not been well worked out, but it has been found as far south as Chili and from thence as far north as Mexico, beyond which to Alaska it is replaced by the allied species *S. melanocephala,* which is common on Vancouver Island.

17. Numenius cyanopus.
(Australian Curlew).

Numenius cyanopus, Vieill., 2nd ed. Nouv. Dict. d'Hist. Nat., vol. viii., p. 307, (1817); Gould, Handb. B. of Austr., ii., p. 277, (1865); Ramsay, List Austr. B., p. 20, (1888).
Numenius Australis, Gould, B. of Austr., vi., pl. 42, (1848).

The migratory movements of this species are somewhat difficult to follow, inasmuch as it wanders far north along the Asiatic coast during the northern summer, and is not found in intermediate localities while on passage. Hence it avoids the Philippines,* and the only record I can find of its being met with in the Malay Archipelago is Swinhoe's statement (B. of China, P.Z.S., 1871, p. 411), recording it from the Moluccas during the season of migration. These islands are immediately to the south of the Philippines, and the natural inference to be drawn from its presumed absence from that group is that it has been overlooked. It is stated by Schreuck to occur in Amuria, and it is common during the summer in Yezo, visiting also the north island of Japan. On the north coast of China it is common in August, but has not been met with on the south coast, though found in the neighbouring island of Formosa. It has been procured at Lumbdan in N.W. Borneo, but I find no record of its occurrence in the more western islands of Java and Sumatra. In New Guinea it is found on passage to Australia, and on arrival on the north shores of the continent it locates itself along the northern territory, and wanders in considerable numbers

* In my note on this species (Journal R. S. of Tasmania), I erroneously stated that it was found in the Philippines, but on consulting the revised list of the Philippine birds contained in the ornithological works of the Marquis of Tweeddale, the only Curlew found in these islands appears to be the Whimbrel.

down the east and west coasts, being recorded from nearly all the districts under recent observation. It is common in the southern colonies too, and arrives in numbers in this island at the end of August or beginning of September. In Western Australia Mr. Campbell has met with it in the Houtmann's Abrolhos in December. It is nowhere more abundant than in Tasmania and the Straits Islands, and many non-breeding birds remain with us all the year round. Dr. Holden writes me that he has met with it in every month in the year on the N.W. Coast, and that it is most numerous in the months of August and September. This Curlew occurs as a straggler in New Zealand, but does not appear to extend into Polynesia, where its place is taken by an allied species, *N. femoralis.*

18. Numenius phæopus.
(Whimbrel).

Scolopax phæopus, Linn. Sys. Nat., p. 243, (1766).
Scolopax luzoniensis, Gmelin, S.N., i., p. 656, No. 21 (1788), ex Sonnerat.
Numenius uropygialis, Gould, P.Z.S., pt. viii., p. 175; Handb. B. of Austr., ii., p. 279, (1865); Legge, B. of Ceylon, p. 910, (1880); Ramsay, List Austr. B., p. 20, (1888).

In treating of the so-called Australian Whimbrel for the purposes of this paper, I still adhere to the opinion expressed in the "Birds of Ceylon" that it is scarcely separable from the Indian bird which is identical with the European. The species inhabiting our coasts is admitted to be the same as the Malayan and Eastern-Asiatic form, *N. luzoniensis,* Gmelin, and examples examined by me from Formosa have the rump barred with brown in a similar manner to immature birds from Ceylon. This being the main characteristic on which Gould founded his Australian species (long previously, however, described by Gmelin), it cannot well stand as a good diagnostic until the breeding-grounds of this supposed species are discovered and *adults ascertained to possess the barred rump.* The advocates of the Malayo-Australian bird as a good species are Herr Meyer, Count Salvadori, and Mr. Swinhoe, and I notice that Dr. Ramsay follows them, using, however, Gould's synonym *uropygialis.* Lord Tweeddale, Messrs. Dresser, Saunders, and other ornithologists unite both forms. In adopting this course the geographical distribution of the Whimbrel is a very wide one. Taking that of the eastern race as the usual method of this paper, we find the Whimbrel migrating as far north as Eastern Siberia,

though not yet recorded from Amoor Land, frequenting the north island of Japan and Kamtschatka in the summer, and passing in autumn down the coasts of Japan and China, through Formosa and the Philippines to the Malay Archipelago, and thence to Australia, spreading, furthermore, throughout a considerable portion of Polynesia. In the Malay Archipelago it has been met with from September till March in the islands of Morotai, Batchian, Aroo, Ternate, Borneo, Halmahera, Ceram, South and North Celebes, and others; while from March until August (the breeding season of northern migrants), Herr Meyer informs me that it has been found in Celebes, Halmahera, Ceram, Flores, Ternate, New Guinea, and Mactan (Philippines). A more westerly stream of migration, perhaps passing down the Malay Peninsula, supplies Sumatra and Java with the birds found there. In Australia it is universally distributed round the entire coast-line, but has not been recorded from the interior, though doubtless future observers may meet with it on the Murray. It appears not to have been noticed of recent years in Tasmania, but it will no doubt be found to affect suitable localities in company with the Curlew when more attention is given to our shore birds. It occurs as a straggler in New Zealand and Lord Howe's Island; and in Polynesia its range extends through the Caroline and Marshall Islands, New Caledonia, the Loyalties, and Fiji, which appears to be its easterly limit in the Pacific.

Turning now to the western form of the species, the Whimbrel is a cold-weather visitant from Central Asia to India, Burmah, Pegu, Tennasserim, the Andaman Islands, and Ceylon. It is more a littoral bird than the Curlew, and arrives in Ceylon in September, leaving again in March. Along the coast of Sindh and the Persian Gulf it has been met with, and is doubtfully recorded from Palestine. In Northern Europe the Whimbrel is common, in the summer breeding in Eastern Russia, Norway, Sweden, and Lapland. It likewise nests in Iceland, the Shetlands, Orkneys, and the north of Scotland. In England it is most plentiful in spring and autumn, while on passage to and from the north; but in Spain, Portugal, the Azores, and Cape Verde it is chiefly found in winter. In the autumn it migrates along the coast of Africa, being found in Egypt and Abyssinia, and extends down both sides of the Continent to Cape Colony, and is likewise met with in the Seychelles, Madagascar, Bourbon, and Reunion.

Westward of the Atlantic it has been found only in Greenland.

19. Numenius minor.

(Little Curlew).

Numenius minor, S. Müller and Schlegel, Verhand, Nat. Geschichte, p. 110, (1839–44); Gould, Handb. B. of Austr., ii., p. 280, (1865); Ramsay, List Austr. B., p. 20, 1888).

The Little Curlew is a migrant from Eastern Siberia, passing down the coasts of China on its way from that region and returning thither in April, during which month Swinhoe records it as fairly common at Shanghai. It has likewise recently been procured at Yokohama in October, so that it doubtless remains in small numbers during the summer in Japan. In the Malay Archipelago it has been found on migration in Celebes, the Aru Islands, and Amboyna, but I find no record of its occurrence in New Guinea, though it most likely frequents the west coasts of that island which are tolerably contiguous to the afore-mentioned islands. In Australia Gould procured it at Maitland (New South Wales) in the month of April, and speaks of it as being found at Port Essington. It is noted by Dr. Ramsay from the Gulf of Carpentaria, the Wide Bay District, the Clarence River District, Victoria, South and West Australia; it would appear therefore to pass round the entire coast of Australia during its "winter" wanderings. There is no record of its presence in New Zealand or in the Polynesian region. The migratory path of this species is shown by the above sketch to be a narrow one, as it has not been met with in the Philippines, passing no doubt through the Moluccas and Celebes, and perhaps along the north-east coast of Borneo (though not yet recorded from that island) to the coast of China.

Fam. Chardriidæ.

20. Recurvirostra novæ hollandiæ.

(Australian Avocet).

Recurvirostra novæ hollandiæ, Vieill, Nov. Dict. of Hist., Nat., iii., p. 103, (1888).

Recurvirostra rubricollis, Temm, Man. d'Orn., ii., p. 592, (1820); Gould, Handb. B. of Austr., ii., p. 249, (1865); Ramsay, List Austr. B., p. 20, (1888).

This handsome Avocet inhabits the continent of Australia from north to south, and is an occasional straggler to Tasmania, New Zealand, and Norfolk Island. Mr. Campbell writes me that it has been procured in the Gulf of Carpentaria, and it

is recorded in Dr. Ramsay's List from Derby and Rockingham Bay. Southwards of the latter locality it is found along the east coast to Victoria and thence round to South Australia, in the southern part of the interior of which colony it is also to be met with. In the wet season of early spring it is doubtless likewise found in the interior of West Australia. I found it common in the month of August on marshes in Riverina, and several pairs noticed there appeared by their actions and anxious movements to be breeding in the locality. In this colony its visits have been chiefly confined to the north coast, where Mr. E. D. Atkinson informs me he has seen it on one or two occasions. In New Zealand, Buller records it from the Ashburton and Kaiapoi Rivers, the south-west coast of the Wellington Province, Dunedin, the Whakatipu Lake, and other localities.

21. Himantopus pectoralis.

(Banded Stilt).

Leptorhynchus pectoralis, Dubus, Mag. Zool., v., pl. 45, (1835).
Cladorhynchus pectoralis (Dubus), Gould, Handb. B. of Austr., ii., p. 248, (1865); Ramsay, List Austr. B., p. 20, (1888).

The Banded Stilt is an inhabitant of the southern portion of the continent of Australia, ranging on the east as far north as New South Wales, and on the west up to the Perth District. It is not improbable that as scientific exploration progresses its range will be extended in West Australia farther north than the above district, as there are doubtless littoral tracts of country in that well-known region well suited to its habits. As far as is at present known the Banded Stilt is somewhat erratic in its movements during the season of its internal or local migration, inasmuch as it appears in great numbers in certain localities, while it is unknown in others contiguous to them. Mr. Campbell writes me that on the 18th November, 1889, it appeared on the lake in Rottnest Island in parties of ten to twenty, apparently coming from the far interior, as none were observed on the adjacent mainland. They increased daily till thousands covered the lake, and they departed again in April without breeding. Captain Sturt, as recorded by Gould, saw it in large flocks in the interior, and states that it was very abundant on Lepson's Lake to the north of Cooper's Creek; he likewise saw it on Strzelecki's Creek. It is not stated at what season of the year Captain Sturt met with the Banded Stilt, nor in what plumage the

birds were, so that his discovery gives no clue to the breeding-grounds of the species—a point of special interest. From the fact of the bird not breeding on the coast of West Australia in the summer it may be inferred that it resorts to the region round the large lakes of the interior, such as Lakes Earle, Austen, and others, where it probably breeds in the early spring during the rains and then migrates to the coast districts. In Tasmania it is said to have occurred as a rare straggler, having been procured in the south. I have not received evidence of its occurrence on the north coast, but it may be met with on some future occasion in localities such as the mud-flats on the Tamar or near Port Sorell.

22. Himantopus leucocephalus.

(Australian Stilt).

Himantopus leucocephalus, Gould, P.Z.S. to 37, p. 26, Handb. B. of Austr., ii., p. 246, (1865) ; Ramsay, List Austr. B., p. 20, (1888).

This Stilt, which is an inhabitant of every colony in Australia, ranges from Tasmania northwards through the Continent to Malayana and the Philippines, in which group it has been met with in the island of Mindano ; it has also occurred there in Billiton. It is a resident bird in Australia, but apparently migrates in parts during the autumn and winter season of this hemisphere towards the Malay Archipelago, where it has been found in New Guinea, Amboyna, Ternate, and Celebes, affecting the latter island from August till October, during which time it breeds there, according to Rosenberg. It is likewise met with in Java, Borneo, Timor, and Sumbawa. In the Philippines, which constitute its northern limit of range, it is met by its near ally *H. caudidus*, which strays southward as far as that group from the Indian region. In Australia the Stilt is found along the extreme north coast and in the Kimberley district, down the east and west sides of the continent to Victoria, and in Tasmania as a straggler. It ranges into the interior of the continent, from whence it is recorded in Dr. Ramsay's list, and I learn that it was recently procured on the overland trip by Dr. Ziest, of the Adelaide Museum. I have myself seen it in numbers in Riverina at the latter end of August, and am of opinion that it breeds there. In New Zealand it is a resident species, and according to Buller is a common bird in the middle and southern portions of the colony, appearing often in large flocks in the vicinity of Napier.

23. Himantopus novæ zealandiæ.

(Black Stilt).

Himantopus novæ zealandiæ, Gould, P.Z.S., 1841, p. 8; Buller, B. of New Zealand, 2nd ed., vol. ii., p. 24, (1888).

The Black Stilt, which is an inhabitant of New Zealand, has appeared in Australia, where two examples were killed at Port Nicholas in immature plumage, and on which Gould founded the species. According to Buller it is rare in parts of New Zealand, being found in the river courses of the Wellington district and further south. He records it from North Cape, Kaipara, the Rotorua Lake, and Lake Taupo; while in the Rotomahana Lake District it is common. Its occurrence in Australia, as also the recent visit of the small black Cormorant, *Phalacrocorax brevirostris* to the Tasmanian coasts, are indicative of probable future visits of New Zealand sea and shore birds to our region.

24. Squatarola helvetica.

(Grey Plover).

Tringa helvetica, Linn, Sys. Nat., i., p. 250, (1776).
Squatarola helvetica (Linn), Gould Handb. of B. of Austr., ii., p. 224, (1865); Legge, B. of Ceylon, p. 929, (1880); Ramsay, List Austr. B., p. 19., (1888).

This fine Plover, which has such a wide Asiatic and European distribution, is more limited in its Australian and Polynesian range then the following species. Its breeding-grounds in Northern Asia extend from Central Siberia (the Taimyr Peninsula) eastward to Kamtschatka. Von Middendorff found it breeding in the Byrranga Mountains, lat. 74°, and in the Boganida near lat. 71°, in the Taimyr Peninsula, in which region it was observed to arrive about the 24th May. Von Schrenk also met with it in Amoor Land in the summer, and it has been observed in that season in Kamtschatka. From these northerly regions it migrates through Central Asia to Turkestan, and in Kashgar it has been noticed as late as the month of November, long before which time it has spread over India, Burmah, Ceylon, and the islands of the Bay of Bengal. It arrives in Ceylon in very limited numbers as early as October. Farther to the east it passes down the coast of China, through Hainan, Formosa, and the islands of Japan to the Malay Archipelago and Australia. There it has been noticed in Borneo, Java, Labuan, the Philippines, Timor, and New Guinea, and is

doubtless distributed through the whole Archipelago. In Australia it has not yet been recorded from the north coast, where it has been probably overlooked, owing to its habit of associating in two's and three's, or going about singly. It has however been procured at Rockingham Bay, the Clarence River, and Richmond districts, and in the colonies of Victoria and South and West Australia. In Tasmania it is found in small numbers, chiefly on the north coast, in which locality Mr. Atkinson informs me stragglers may be seen in the summer season. It does not appear to diverge into Polynesia, nor is it found in New Zealand.

Regarding its distribution in the western portion of the Palœarctic region and Africa, I transcribe the following from my Birds of Ceylon:—"Canon Tristram records it as a winter visitor to Palestine, and Robson as not uncommon in Asia Minor in autumn, a few staying through the winter. Lord Lilford procured it in the Epirus, and Lindermayer and Von der Mühle record it from Greece. In Malta, Sicily, and Sardinia it is a winter visitor, and in Spain, according to Mr. Saunders, is more common on passage than in winter, he obtained it in May in breeding plumage in Malaga. In Portugal it is said to be common." . . . . . "In Transylvania it occurs on migration, but rarely; further east it appears to pass through Southern Russia and up the Volga, being noticed in occasional seasons in the Kasan district. From here Messrs. Seebohm and Harvie Brown say that it probably passes down the Petchora to about the mouth of its tributary, the Assa, and then spreads over the vast Tundras to the north east, on which these enterprising naturalists were so fortunate as to take its eggs a few years since. The latter author met with it likewise near Archangel, but was told by the inhabitants that it did not breed there. There is much yet to be learnt concerning its breeding home, for we have yet to discover the whereabouts in the nesting time of those which migrate up the Baltic from western Europe.* In Great Britain the Grey Plover is fairly common on passage, arriving in spring and passing on in May to the north, and in Scotland Mr. Saunders remarks that it is "more abundant on the east coast than on the west," passing thence no doubt into

* I think it right to mention for those who possess the "Birds of Ceylon," that by some extraordinary oversight, probably through a missing sheet of manuscript, the distribution of this cosmopolitan species in the British Isles has been omitted! The fact was not discovered by me until the preparation of this paper.

Norway and up the Baltic. It returns to England as early as August, but the same author remarks that "the bulk of the old birds come in October and November, by which time the majority have assumed the winter garb." It is less common in Ireland than in England. "Leaving the Continent of Europe and referring now to its African distribution, I find that, according to Col. Irly, Favie states that it is seen about Tangier from December until March, and Mr. T. Drake likewise records it from Morocco. It has been noticed in Algeria, and in Egypt it is distributed throughout the Delta and north coast in winter; and Von Heughlin says it is found along the coast of the Red Sea and in Kordofan where he observed it as late as April. It extends down both sides of the Continent to the Cape of Good Hope, and spreads eastward to Madagascar and the Seychelles, from both of which regions Mr. E. Newton records it. Captain Sperling noticed it as being common in Zanzibar; and in Natal Mr. Ayres procured it. . . . . In Damara Land Mr. Anderson obtained it in winter. Further north it has been obtained in Gaboon, as also on the Gold Coast and in Senegambia."

In America the Grey Plover ranges in summer from Greenland, where it breeds, along the shores of the Arctic Ocean to Alaska. Its autumn migration takes place down the east coast to the West Indies, where it has been met with in Cuba, Trinidad, Jamaica, and the Bahamas. In Central America it is recorded from Guatemala, to and from which region it probably passes, and where it is found in spring and autumn.

25. Charadrius fulvus.

(Eastern Golden Plover).

Charadrius fulvus, Gmelin, Sys. Nat. i., p. 687, (1785); Legge, B. of Ceylon, p. 934, (1880); Ramsay, List Austr. B., p. 19, (1888).
Charadrius xanthocheilus, Gould, B. of Austr., Vol. vi., pl. 13, (1848).
Charadrius orientalis, (Temm), Gould, Handb. of B. of Austr. ii., p. 225, (1865).

The Eastern or Asiatic Golden Plover is a bird of wide Asiatic and Polynesian range, and is a remarkable instance of a North-Asian breeder which sporadically nests in the South Pacific. Speaking generally, the breeding habitat of this species extends from about the valley of the Yenesei River

eastward across the Tundras of Northern Siberia, to the shores of the sea of Okhotsk and the peninsula of Kamtschatka. In this region it does not breed so far north as the Grey Plover, though I am not able to give any precise limit to its Arctic migration beyond the statement that Mr. Seebohm found it breeding abundantly at Golcheeka on the Yenesei. From these northern regions it migrates in vast numbers southward through Mongolia and down the coasts of China and Japan; passing westwards into India, Burmah, Ceylon, and Malacca, and eastwards through the Malay Archipelago to Australia, spreading from the former region outwards to Polynesia, and from Australia to New Zealand. It arrives in India and Ceylon as early as the month of August, numbers of examples still wearing the breeding plumage, and is very abundant. It probably passes into the Peninsula from the highlands of Mongolia and Tartary, crossing over the eastern spurs of the Himalayas into Assam and Burmah, and then spreads westwards through India. In the extreme north-west of India it is not so abundant, a few birds migrating perhaps *via* Turkestan over the mountains into the Punjaub, for it is recorded from the district of Gilgit as a bird of passage in spring and autumn. It leaves India for its breeding-grounds as late as the month of May, many examples being then almost completely clothed in breeding dress. In Mongolia and on the Amoor it is found on passage in spring and autumn, and the same may be said of the coast of China, the islands of Hainan and Formosa, and the Philippines. From thence it wanders eastwards into Polynesia, being found in the Loochoo Islands, the Pelews, the Carolines, the Marshalls, and Gilberts, the Sandwich Islands, and as far east as the Marquesas. In the Marshalls, Dr. Finsch met with it as early in the season as August. Further south it occurs in the New Hebrides, New Caledonia, the Loyalty Islands, and Fiji, while on some small islands off the coast of New Caledonia it was found breeding by Edgar Layard in the month of April. A more remarkable feature, however, in the economy of this plover is its breeding in New Zealand during the summer season of this hemisphere, which is in reality the winter time of its migration. The authority for this occurrence is to be found in a paper by Mr. C. H. Robson, communicated by Buller to the "Transactions and Proceedings of the New Zealand Institute, vol. xvi., p. 308," in which the former writer states that he found the Golden Plover breeding at the north end of Portland Island in the month of January, 1883,

This locality is at the east side of Hawke Bay, on the coast of the North Island. It is difficult to account for this singular irregularity in the habits of a truly migratory species except on the supposition that the birds were immature examples of the previous year which had remained throughout the southern winter in New Zealand and had acquired the breeding impulse as the summer of their adopted country approached. It occurs along the coasts of both islands of New Zealand, and is a straggler to Norfolk Island.

Retracing the distribution of this species to Southern Asia, we find other migratory flocks passing probably down the Malay Peninsula and occurring on passage in the Malay Archipelago, in the islands of Sumatra, Java, Borneo, Celebes, Bourn, Ceram, Batchian, and others. On both the west and south coasts of New Guinea it has also been found, and thence it passes to the Australian continent, along the coasts of which it is found on the east, west, and south sides, being likewise recorded from Port Darwin and the Gulf of Carpentaria. It is common in Victoria and is tolerably plentiful in Riverina and other suitable districts of the south of the continent. It usually arrives in Tasmania about the month of October and remains until March or April following, at which season examples are to be found, according to Dr. Holden, in the Circular Head District. A few birds are, however, to be seen on the north coast, Mr. E. D. Atkinson writes me, in the winter months, these being probably immature individuals of the previous season. It is not uncommon on the Salt Pans in the Tunbridge District during the summer, and is found on the islands of Bass Straits.

Returning to Asia we find this Golden Plover tolerably scarce in the western* portion of the continent, where its place is taken by its near ally, the Golden Plover of Europe, *Ch. pluvialis.* It occurs in Astrakan in the autumn and wanders south into Persia, where it is found at Muscat on the Gulf. Individuals however, stray in a remarkable manner into Europe, probably accompanying their ally from the breeding haunts of the latter on the Yenesei River: thus examples have been procured at Archangel, and stragglers have been obtained at Heligoland, in Holland, and in Malta, where an individual was shot in May, 1861.

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* At page 937 of the "Birds of Ceylon" there is a printer's error (noticeable from the context), in which "south-eastern" should read *south-western.*

26. EUDROMIAS AUSTRALIS.
(Australian Dotterel).

Eudromias australis, Gould, P.Z.S., pl., viii., p. 174, Handb. B. ot Austr., ii., p. 227, (1805) ; Ramsay, List Austr. B., p. 79, (1888).

This handsome bird, the Australian prototype of the well-known European Dotterel, is an inhabitant of the interior of the southern portion of the continent. It was first discovered by Captain Sturt on the highlands near the River Murray in South Australia. As quoted by Gould, this traveller writes as follows :—"This singular bird made its appearance in 1841 suddenly on the plains of Adelaide, seeming to have come from the north. It occupied the sandhills at the edge of the mangrove swamps, and fed round the puddles of water on the plains." It is not uncommon, according to my own experience on the plains of Riverina between Deniliquin and Hay, being found occasionally on the sandy wastes of the large sheep-runs in that district. Dr. Ramsay informs me that it is has bred in Riverina, and he has obtained it in other parts of New South Wales. Mr. Campbell writes me that it is found in the Murchison district, West Australia, breeding there also. Its range no doubt extends further north, particularly on the west side of the continent, than has been ascertained up to the present time.

27. EUDROMIAS ASIATICUS.
(Eastern Dotterel).

Charadrius veredus, Gould, P.Z.S., 1848, p. 38; Harting, Ibis, 1870, p. 209 ; Ramsay, List Austr. B., p. 19, (1888).
Cirrepidessinuus asiaticus, (Pallas), Gould, Handb. B. of Austr., ii., p. 229, (1805) ; Finsch, Ibis, 1872, p. 144.*

This species was described as an Australian bird by Gould from a Port Essington specimen, and was thought for some time to be peculiar to our continent and the Malay Archipelago. It is now known, however, to have an extended range towards the north, being identical with the Asiatic bird described by Pallas. Its breeding-grounds are apparently in the north of China, or perhaps beyond that, in Amoor Land. Its migratory path appears to be narrow as it passes down the coasts of China and Japan, but does not spread to the westward into Asia. It is found, however, in Java, Celebes, Amboyna, Ternate, New Guinea, and the Aru Islands. In these localities it has been met with in the immature stage or in the

* Dr. Finsch in referring in this paper to Mr. Harting's exhaustive article on this species, clearly shows that this bird is the *Ch. asiaticus* of Pallas.

non-breeding plumage of the adult, but at Shanghai it has been obtained in nuptial dress. In Australia Dr. Ramsay records it from the Wide Bay District, and notes it doubtfully from Rockingham Bay. Gould obtained it near Sydney, and it may possibly be found in the Riverina District if it strays so far inland as that province.

28. ÆGIALITIS GEOFFROYI.

(Large Sandplover).

Charadrius geoffroyi, Wagler, Syst. An., fol. 4, p. 13, (1827).
Ægialitis geoffroyi, Harting, Ibis, p. 378, pl. ii, (1870); Legge, B. of Ceylon, p. 939, (1880); Ramsay, List Austr. B., p. 19, (1888).

The range of this species extends from the north coast of China and Japan, through the Malay Archipelago to the north-east coast of Queensland, in which province Rockingham Bay is up to the present time its southernmost limit. Further west in Asia it is found in the summer in Turkestan and probably in the contiguous highland territory of Central Asia, and extends thence during migration in the cool season to India and Ceylon, where it is a tolerably common bird from October until the following April. It is chiefly a littoral species, never being found at any great distance from the sea, and often consorts with the Sandplover next to be noticed. In Ceylon immature birds are occasionally to be seen during the breeding season, but there is no evidence of this plover having bred either in India or Ceylon. On the coasts of China it may be met with both in winter and summer, and it has been known to breed in the island of Formosa. It occurs on migration in the Pelew Islands and in the Philippine Group, but in Celebes it has been obtained in the breeding season. It is recorded from the south coast of New Guinea, and probably frequents other islands of the Archipelago, but owing to its habit of not associating in large flocks it may have been overlooked. It has been obtained on the north coast of Australia and on the north-west side of the continent as far south as Derby.

Returning to its distribution in Asia, it is found in Palestine and parts of Asia Minor, from which latter country I have seen specimens in breeding plumage. From this region it extends through Egypt to the Gulf of Aden, where Von Heughlin considers that it is a resident. To the south of this it is found along the east coast to Cape Colony and diverges eastward to the Seychelles, Mauritius, and Madagascar.

On the south-west coast of this continent it has been procured at Benguela. In Europe it has, according to Giglioli, the Italian naturalist, occurred in Italy, and it may possibly be found in Southern Russia, as it has been met with on the eastern shores of the Caspian Sea.

29. ÆGIALITIS MONGOLICA.

(Mongolian Sandplover).

Charadrius mongola, Pallas, Reese, iii., p. 700, (1776).
Ochthrodromus inornatus, Gould, Handb. B. of Austr., ii., p. 237, (1865).
Ægialitis mongolicus, (Pallas) Harting, Ibis, 1870, p. 384; Legge, Birds of Ceylon, p. 943, (1880); Ramsay, List Austr. B., p. 19, (1888).

The Mongolian Sandplover has a wide oriental range, but is more restricted in its African distribution than the afore-mentioned species. Like that bird it is found in Turkestan, where it breeds, and migrates in the cool season to India, Burmah, Ceylon, the Andamans, and southwards to Singapore, and the Malay islands. In this sub-region it has been met with in Borneo, Java, Ceram, the Aru islands, and New Guinea, from which latter place it finds its way to the north coast of Australia, along which it is found extending southwards to Rockingham Bay, from where Dr. Ramsay records it, and beyond which in this direction it has not yet been met with.* In the Indian and Ceylonese sub-region it is very abundant, many non-breeding birds remaining there throughout the year. Eastward of Turkestan it is found in Thibet, Mongolia (where Pallas first described it from), parts of South East Siberia, the Corea, on the shores of the Sea of Okhotsk, in Japan, and thence northwards to the Choris Peninsula in Behring Strait. On migration to and from these northern localities it is met with in South East China and the Philippines, south of which the migratory flocks probably join the more westerly ones which we have seen pass down the Malay Peninsula to the larger Malay islands.

In Western Asia, like the last species, the Mongolian Sandplover is found in Palestine, in the Persian Gulf, and along the Red Sea, but southwards on the African coasts it appears to be rarer than in the afore-mentioned localities,

* I have examined a Sandplover shot in the north of Tasmania which is doubtfully referable to this species, corresponding in general plumage, length of wing, bill, and tarsus with Ceylonese examples in my collection, but the indistinct markings across the chest point to the possibility of its being an immature *Ægialitis bicincta*.

Von Heughlin being the only naturalist who, I find, records it from the Somauli District. It will thus be seen that it has a more northerly range than its larger congener, and does not migrate so far south, so far as Africa is concerned.

30. ÆGIALITIS MASTERSI.

(Master's Sandplover).

Ægialitis mastersi, Ramsay, P.Z.S., New South Wales, vol. i., p. 135, List Austr. B., p. 19, (1888).

This interesting Sandplover, which is an addition to Australian avi-fauna made by Dr. Ramsay *loc. cit.*, is an inhabitant of the north coasts of the continent and south of New Guinea, affecting likewise in all probability the islands of Torres Straits. The localities from which it is recorded on the north coast are the Gulf of Carpentaria and Rockingham Bay, and its presence may no doubt be looked for farther south on the Queensland coast.

31. ÆGIALITIS BICINCTA.

(Double-banded Dotterel).

Charadrius bicincta, Jard. & Selby, Ill. Orn., vol. i., pl. 28.
Ochthodromus bicinctus, (Jard. & Selby), Gould, Handb. B. of Austr., ii., p. 238, (1865).
Ægialitis bicincta, (Jard. & Selby), Ramsay, List Austr. B., p. 19, (1888).

The Double-banded Dotterel, or Sandplover, is one of the most puzzling of our shore migrants, appearing in Tasmania at the opposite season of the year to most members of its family. It is apparently a southern breeder wandering as a local Australian migrant to the northern portions of the continent. Judging by what Sir W. Buller writes of it in his second edition of the "Birds of New Zealand," it is a resident species there, being common on the shores of both islands, and commencing to breed in August. A migration to Tasmania probably from more northern parts of Australia, and possibly in part from New Zealand, appears to take place towards the latter end of summer, and after the months of April and May the species is plentiful in some of the inland districts, as well as on the coasts. A favourite locality for the Double-banded Sandplover is about the Salt Plains near Tunbridge, and it may be met with on the sandy foreshores of many of the inlets and bays in the south of the island. Messrs. Atkinson and Holden inform me that it is common on the north coast and in the eastern islands of the Straits

during winter. It disappears from the mainland in the spring and probably breeds on some of the Straits Islands, the young birds found here in the autumn coming most likely from that locality. In his Handbook Gould alludes to a migration of this species observed by him at George Town on the 15th of May, which is about the time they would be arriving on a southern migration from their breeding-grounds. This bird ranges through Australia from Victoria to Queensland and Western Australia, and is likewise found on the north coast of the continent and in southern New Guinea. It has not been recorded from the far interior of Australia, but doubtless occurs in Riverina. Eastward in the direction of Polynesia, besides being found in New Zealand it has been met with in Norfolk Island, whence Dr. Ramsay informs me young birds have been sent to the Sydney Museum.

32. ÆGIALITIS MONACHA.

(Hooded Dotterel).

Charadrius monachus, Geoff., Mus., Paris.
Ægialitis monacha, (Geoff.), Gould, Handb. B. of Austr., p. 231., (1865) ; Ramsay, List Austr. B., p. 69, (1888).

This handsome Dotterel, which is essentially an Australian species, ranges from the southern parts of the Queensland coasts to Tasmania, where it is a common bird resident chiefly on the ocean beaches. In the former locality it has been met with at Wide Bay, and further south, on the shores of New South Wales and Victoria, it is common. It is also recorded in Dr. Ramsay's list from South and West Australia, but how far north it extends in the latter colony is not specified. As further exploration on the west coast of the continent is proceeded with it will no doubt be observed as far north as the Kimberly coast. It is pretty evenly distributed all round the coast of this colony, and is found on the beaches of Bass Straits islands.

33. ÆGIALITIS NIGRIFRONS.

(Black-fronted Dotterel).

Charadrius nigrifrons, Cuvier, Mus., Paris.
Ægialitis nigrifrons, (Cuv.), Gould, Handb. B. of Austr., ii., p. 233, (1865) ; Ramsay, List Austr. B., p. 19, (1888).

This elegant little Dotterel, which, like the last species, is confined to Australia, has a more northerly range than the Hooded Dotterel, but does not stray so far south, as it has not yet been observed in Tasmania. The most northerly

locality given by Dr. Ramsay is Rockingham Bay, and thence down to Victoria and South Australia; it is recorded from all localities in his "List." In West Australia it extends as far north as King's Sound, having been procured at Derby. It frequents inland districts on the Continent, being one of the species of its genus which does not confine itself to littoral districts, equally prefering inland waters and marshy localities at the head of sequestered inlets. Gould found it breeding on the Namoi, and I know it has been obtained in Riverina, not far from the Murray.

34. ÆGIALITIS RUFICAPILLA.

(Red-capped Dotterel).

Charadrius ruficapillus, Temm., Pl. Col. 47, fig. 2, (1838 ?).
Ægialophilus ruficapillus, (Temm.), Gould, Handb. B. of Austr., ii., p. 235, (1865).
Ægialitis ruficapilla, (Temm.), Ramsay, List Austr. B., p. 19, (1888).

This elegant little bird, the smallest of the Australian shore plovers, is a resident of the Australasian sub-region, extending from Tasmania northwards as far as the South East coast of New Guinea. On the north coast of the continent it is recorded from all localities where collections have been made, but it has not been met with on the far north-west coasts, but in that distant part it has no doubt been overlooked. Further south, in the Perth District, it is common, as is likewise the case on the south and east coasts of Australia. It has likewise been obtained in the interior, and I have observed it in marshy districts north of the Murray in August. In Tasmania it is one of the commonest of our small shore birds. It extends to New Zealand, being recorded as a straggler to the colony by Buller.

35. ÆGIALITIS HIATICULA.

(Ringed Dotterel).

Charadrius hiaticula, Linn., Sys. Nat. i., p. 253, (1776).
Ægialitis hiaticula (Linn.), Gould, Handb. B. of Austr., ii., p. 231, (1865); Ramsay, List Austr. B., p. 19, (1888).

Apparently the Ringed Dotterel of Europe takes its place in the avi-fauna of Australia on the evidence of a single example, which Gould states was killed at Port Stevens. Dr. Ramsay writes me that he knows of no other instance of its occurrence, which proves that this bird is a very rare straggler to the Australian region, as it has proved itself likewise to the

southern portions of the Old World. The range of this species extends along the Arctic Circle from Greenland, eastwards through Siberia, to the vicinity of Behring Straits. It has been known to breed as far north as the 80th parallel, and it has reared its young in Greenland and Iceland. In winter it migrates from high latitudes towards the south, but it is resident in the British Isles, France, Holland, and Central Europe generally, though Mr. Howard Saunders speaks of it as rare in extensive inland territory such as Russia. In Southern Europe it is rarer than in the north, though in parts of Portugal it is said to be plentiful. Mr. Seebohm writes of it as common on the Steppes of Astrakhan in the summer months. In Southern Europe and the northern parts of Africa there is a smaller race of this plover, the *Ægialitis intermedia* of some authors, but which Mr. Saunders scarcely considers of specific distinctness, and accepting this view, the range of the present species would extend through the north of Africa to the Canaries and the island of Maderia. In Central Asia the Ringed Plover does not appear to be plentiful, according to the observations of ornithologists, in that region, but it breeds in Turkestan. From there it has been known to cross over the ranges to Gilgit, to which district it is a rare straggler, while farther south in the Peninsula of India it has only once been obtained, near Delhi. From China I do not find it recorded, that region being inhabited by an allied species *Æ. placida*, Grey. Its occurrence at Port Stevens, if it was correctly identified, is very remarkable, as the example must have wandered southward in company with other *limicoline* birds through the Malay Archipelago, but from what starting-point it is absolutely impossible to conjecture, the species being so rare in Southern Asia. It is more probable, I would surmise, that Gould's bird was the Chinese form, *Æ. placida*.

ÆGIALITIS JERDONI.

(Little Indian Ringed Plover.)

Ægialitis minutus, (Pallas), Jerdon, Birds of India, iii., p. 641, (1864).
Ægialitis jerdoni, Legge, P.Z.S., 1880, p. 39; Ramsay, in part, List Austr. Birds, p. 19, (1888).

As there is evidently a second species of Ringed Plover found in the Papuan region, and doubtless also on the continuous coastline of Northern Australia, I think it advisable to include *Ægialitis jerdoni* in this paper as a footnote, thus giving it the character of a doubtful species. Dr. Ramsay writes me, that since issuing his first list of Australian birds, he has received several specimens of a Ringed Plover from Port Moresby, one of which he sent to Count Salvadori, who has stated that it might be *Ægialitis jerdoni*,

36. Erythrogonys cinctus.

(Red-kneed Dotterel).

Erythrogonys cinctus, Gould, P.Z.S., p. v., p. 153, Handb. B. of Austr., ii., p. 240, (1865); Ramsay, List Austr. B., p. 20, (1888).

This interesting Dotterel, which is restricted to the continent of Australia, is mostly an inland species, and appears to have a somewhat irregular distribution over the territory to which it is limited. Apparently it visits New South Wales and the southern parts of the continent on migration from its haunts in the far north, breeding in the former region during its sojourn there. Gould considered it to be a summer visitant to New South Wales in wet seasons, and writing of it as follows:—"In October and November, 1839, I found it tolerably abundant on the flats near Aberdeen and on the upper part of the Dartbrook, a tributary of the river Hunter; and on visiting the Mokai and Namoi I observed it to be equally abundant on those rivers." It is not uncommon in the interior of the southern parts of the continent, viz., on the Darling, in Riverina, along the Murray River, in the north-west of Victoria, and in South Australia. Mr. Campbell writes me that it breeds in the Lower Murray and parts of Riverina. In the extreme north it appears to be a straggler, having been obtained at Derby, and on the Gulf of Carpentaria. To these localities it probably strays from some more permanent haunt in the interior of the north of the continent.

(mihi). There is no mistaking this species, which I discriminated, *loc. cit.*, from the Lesser Ringed Plover of Asia on account of its *thick protuberant yellow eyelid,* and yellow basal half of the under mandible, and in all probability Count Salvadori had no Indian or Ceylonese specimens by him when he examined Dr. Ramsay's bird. This little Sandplover ranges from Northern India through the Deccan to the south of the Peninsula, and thence to Ceylon, where I found it resident in the Northern Province. Major Biddulph procured it in May and September at Gilgit, which is the most northerly locality it has yet been observed in, for it does not seem to cross the Karakoram Ranges into Turkestan. It does not appear to have been noticed in the Calcutta District, but it has been obtained in Furreedpoor. It is said to be common on the banks of the Irrawaddy, and has been obtained in the Province of Pegu, as likewise further south in Tennasserim It has not been observed, so far as I can ascertain, in the Malay Archipelago, and it is doubtful after all whether Dr. Ramsay's birds were of this species. The Port Moresby Plover may be a distinct species peculiar to New Guinea, if not it must be a rare straggler to the Malayan sub-region from Southern Asia, in the same manner as the species identified by Gould as *Ægialitis hiaticula.*

37. Lobivanellus lobatus.

(Wattled Plover).

Tringa lobatus, Lath, Ind. Orn., Suppl., p. 65, (1801).
Lobivanellus lobatus, Gould, Handb. B. of Austr., ii., p. 218, (1865); Ramsay, List Austr. B., p. 19, (1888).

This handsome bird, which might be styled the Australian representative of the English Pewit, is an abundant species in many parts of Tasmania, inhabiting for the most part the interior of the island, where it is to be met with abundantly in the midland, northern, western, and Derwent Valley Districts. It is however found near the sea in suitable localities and is numerous in the Straits Islands. On the mainland it is found in Victoria, South Australia, and New South Wales, and ranges up the east coast of the continent as far as Rockingham Bay. It is not recorded from West Australia, evidently not having penetrated across the desert country between there and South Australia, but notwithstanding further exploration may lead to its discovery in the Western colony.

38. Lobivanellus miles.

(Masked Plover).

Tringa (?) *miles*, Bodd.*
Lobivanellus personatus, Gould, P.Z.S., pt. x., p. 113; Handb. B. of Austr., ii., p. 220, (1805).
Lobivanellus miles (Bodd), Ramsay, List Austr. B., p. 19, (1888).

This handsome Plover is an inhabitant of the northern parts of Australia, being found in the littoral districts of the continent from Cape York to the Kimberley country. It does not appear to extend down the east coast, as it is doubtfully included by Dr. Ramsay in his "List" from Rockingham Bay. Gould speaks of it as being common in the Cobourg Peninsula, and records Breaker Inlet as a locality where a correspondent, Mr. F. T. Gregory, found it common.

39. Sarciophorus pectoralis.

(Spur-winged Plover).

Charadrius pectoralis, Cuvier in. Mus., Paris.
Sarciophorus pectoralis, (Cuv.), Gould, Handb. B. of Austr., ii., p. 222, (1865); Ramsay, List Austr. B., p. 19, (1888).

The range of this fine Plover extends from Tasmania and the Straits Islands northwards through Victoria and South Australia into the interior of the Continent, and on its eastern

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* I am unable to give the original reference in full for this species.

side as far up the coast as Rockingham Bay, beyond which, in that direction, Dr. Ramsay does not record it in his "List." In the central portion of the Continent it was obtained recently by Dr. Zietz on the overland trip with Lord Kintore. Throughout the territory which it inhabits it appears to be a resident species, but it is possible that its numbers in Tasmania may be increased by an influx of birds in the spring from the mainland, as during some years it is noticed to be more plentiful here than at other times. It is not uncommon in the midland districts of Tasmania, being usually noticed about the Salt Pans near Tunbridge, as also on suitable tracts of plain country in the south and north of the Island, but it is nowhere so abundant as the Black-breasted Plover.

Fam. Œdicnemidæ.

40. Esacus magnirostris.

(Large-billed Stone Plover).

Œdicnemus magnirostris, (Geoffrey St. Hilaire), Vieill, N. Dict., xxviii., p. 231, (1818).
Esacus magnirostris, (Geoff.), Gould, Handb. B. of Austr., ii., p. 218, (1865) ; Ramsay, List Austr. B., p. 19, (1888).

If the Malayan Stone Plover be identical with the Australian, the present species has a range extending from the Andaman Islands to Rockingham Bay on the east coast of the Continent. Lord Walden in his note on this Plover (Trans. Z. S., 1872, "Birds of Celebes") refers to Temminck's observation on the example figured by himself as being intermediate between the Indian and Papuan forms, and surmises that the Malayan and Australian species may be distinct. Sufficient data for their separation, however, is not forthcoming, and I accordingly treat of them here as being identical. In Australia Dr. Ramsay notes this plover as being found from Port Darwin along the north coast, and as far south as Rockingham Bay, while Dr. Zietz recently obtained it in the Northern Territory. From Australia northwards it extends as a resident species through New Guinea to Celebes, Borneo, Palawan, the Philippines, Java, Sumatra, and thence onward to the Andamans and the Coco's Islands, where Mr. Hume found it breeding late in the summer (March) of 1874.

Returning to the Polynesian region, Dr. Finsch has obtained in New Britain, and Layard records it from New Caledonia and the Huon Islands, situated between the

French Colony and the New Hebrides. It has also been obtained in the Solomon Group, and may possibly extend eastward as a straggler to Fiji.

41. Œdicnemus grallarius.

(Australian Thicknee).

Charadrius grallarius, Lath, Ind. Orn. Suppl., p. 66, (1800).
Œdicnemus grallarius, (Lath), Gould, Handb. B. of Austr., ii., p. 210, (1865); Ramsay, List Austr. B., p. 19, (1888).

The Australian Stone Plover, or Thicknee, is a widely distributed and resident species on the Australian Continent, but does not cross the Straits to Tasmania. It is found on the plains of Victoria and in the Mallee scrubs of the Murray Districts, and ranges northwards from Riverina into the interior, and through New South Wales into Queensland and along the north coast to Port Darwin. It is found in South Australia and extends thence westwards into West Australia, in which colony it has been met with as far north as Derby. It has not been observed in South New Guinea, the north coast of Australia being as yet the limit of its known range.

Fam. Glareolidæ.

42. Glareola grallaria.

(Australian Pratincole).

Glareola grallaria, Temm., Man. d'Orn., vol. ii., p. 503; Gould, Handb. B. of Austr., ii., p. 243, (1865); Ramsay, List Austr. B., p. 20, (1885).

This fine Pratincole, or Swallow Plover, is a resident species in Australia, but may be said to wander over the continent to some extent, appearing in sundry localities at uncertain times. It is no doubt resident in the northern parts of the interior and also in Central Australia, where it was procured recently by Dr. Zietz, of the Adelaide Museum; from this region it wanders evidently southwards into New South Wales, the Riverina District, parts of Victoria, and the southern portion of South Australia. Mr. Campbell has met with it in Victoria, and I have seen it on the Riverina Plains in the month of November. It probably ranges from South Australia into the arid districts to the north of the Bight, and thence into West Australia. In the northern parts of the continent it has been observed, according to Dr. Ramsay, at Wide Bay, Cape York, Port Essington, and Derby, and Mr. Campbell writes me that it has been procured on the Gulf of Carpentaria. It has not yet been recorded from New Guinea, but it is found

in some of the Malay Islands, for I have examined a specimen in the British Museum from the island of Bourn.

43. Glareola orientalis.

(Eastern Pratincole).

Glareola orientalis, Leach, Tr. Z.S., xiii., p. 132, pl. 13, figs. 1, 2, (1821) ; Gould, Handb. B. of Austr., ii., p. 245, (1865) ; Legge, B. of Ceylon, p. 980, (1880-2) ; Ramsay, List Austr. B., p. 20, (1888).

This fine Swallow-Plover is a bird of wide range, and though resident in sundry localities throughout its habitat, is nevertheless a bird of migratory, or perhaps more strictly of a wandering nature, suddenly appearing in districts where it has not hitherto been seen. I met with it under these conditions on the Northern Province of Ceylon in July, 1875, and then added it to the avi-fauna of that island. Its northern limit, according to the testimony of the celebrated Russian traveller and naturalist, Prjevalsky, is the northern bend of the Hoangho River, where it ranges southwards through Mongolia and China to Formosa, the Philippines (Negros), Java, Borneo, Timor, and thence to the coast of Australia. It is common in Pegu, where it has been found breeding, and occurs in more or less numbers in Tennasserim, the Malay Peninsula, the Andaman, and Nicobar Islands, and Penang. In India it appears to be a cold-weather visitant to the eastern side of the Peninsula, and is rare in Oudh, the North West Provinces, and Sindh. During its visits to the island of Ceylon from the mainland of India it evidently breeds there, as I found it accompanied by young on the shores of one of the great irrigation "tanks" in the Trincomalie Dristrict.

To our continent it is evidently a straggler, being recorded by Dr. Ramsay from four localities, viz., Cape York, Rockingham Bay, Wide Bay, and the colony of New South Wales.

Fam. Hæmatopodidæ.

44. Hæmatopus longirostris.

(White-breasted Oyster Catcher).

Hæmatopus longirostris, Vieill, 2nd edition Nouv. Dict. d'Hist. Nat. vol. xv., p. 440 ; Gould, Handb. B. of Austr., ii., p. 215, (1865) ; Ramsay, List Austr. B., p. 19, (1888).

This handsome Oyster Catcher is resident almost along the whole shore-line of Australia and Tasmania, extending also southwards to New Zealand and the Chatham Islands. It is

omitted from the far north-west coast of Australia in Dr. Ramsay's "List," having probably been overlooked by collectors in that district. Immediately to the north of Australia it is found in New Guinea and the Aru Islands, but it appears doubtful if it extends further north than the Great Papuan Island, as it is not recorded from the Philippine Group, although Mr. Howard Saunders in the second edition of Yarrell's "British Birds" records it from China and Japan. The common species, however, of that region is *H. osculans*, Swinhoe, and I find no mention of our bird in the published catalogues of Chinese and Japanese shore birds. It is possible, therefore, that the identifications on which Mr. Saunders based his distribution in that part of the world of *H. longirostris* may have been erroneous.

The Polynesian range of this latter species seems to be restricted to the afore-mentioned localities, New Zealand, and the Chatham Islands, for it is not recorded from New Caledonia, Fiji, or any of the surrounding or intervening groups. This fact may partly be accounted for by the fact that the species, like its congeners, is non-migratory, although it is singular that it should not originally have been located in Norfolk Island, New Caledonia, and other contiguous spots as well as in New Zealand.

45. Hæmatopus unicolor.

(Sooty Oyster Catcher).

Hæmatopus unicolor, Wagler, Isis, 1832, p. 1320; Ramsay, List Austr. Birds, p. 19, (1888).

Hæmatopus fuliginosus, Gould, Handb. B. of Austr. p. 217. (1865).

This large Oyster Catcher, the "Red Bill" of shore sportsmen, is a resident species on all the coasts of the colonies, including the Bass Straits Islands and New Zealand. It is recorded by Dr. Ramsay from Port Darwin and all other explored localities eastward along the north coast, and likewise down the east coast to Victoria, and thence westward to Western Australia. It does not appear to have been noticed yet on the south coast of New Guinea, but probably it exists there, being so well distributed along the adjoining coast of Australia. Its omission in Ramsay's List from N. West Australia is doubtless due to its having been overlooked in that region. In New Zealand it is more abundant, as stated by Buller, in the southern parts than the foregoing species, and is not uncommon in the North Island. I have found it more evenly distributed along our own Tasmanian coasts than the White-breasted species.

46. Hæmatopus opthalmicus.

(Ramsay's Oyster Catcher).

Hamatopus opthalmicus, Castl. and Ramsay, P.Z.S., N. S. Wales, i., p. 384-5, (1876) ; Ramsay, List of Austr. B., p. 19, (1888).

This new species, which is one of Dr. Ramsay's numerous additions to the avifauna of Australia, was procured on the shores of the Gulf of Carpentaria, where only it is recorded from in the "List of Australian Birds." It will probably be found elsewhere on the northern shores of the continent, and perhaps on the contiguous islands of Torres Straits, as well as in New Guinea.

To conclude this notice of the *Limicolæ* of Australia, it will be right to divide them into groups, based on the foregoing outline of their distribution, showing :—

1st. Resident or Non-migrant Species.
2nd. Partial or Internal Migrants.
3rd. Migrants :—
(*a.*) From Eastern Asia.
(*b.*) From Asia and Europe.
(*c.*) In both Palæarctic and Nearctic Regions.

1. Resident or Non-migrants :—

Himantopus novæ zealandiæ.[a]
Ægialitis mastersi.
Ægialitis monacha.
Ægialitis ruficapilla.[b]
Lobivanellus lobatus.
Lobivanellus miles.
Sarciophorus pectoralis.
Œdicnemus grallarius.
Hæmatopus unicolor.[a]
Hæmatopus ophthalmicus.

2. Internal Migrants or Visitants, more or less, to the southern portions of the Continent :—

Rhynchæa australis.
Recurvirostra rubricollis.[a]
Himantopus pectoralis.
Eudromias australis.
Ægialitis bicincta.[a]

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[a] Exists beyond strictly Australian limits : in New Zealand.
[b] Exists beyond strictly Australian limits : in New Zealand and New Guinea.

Erythrogonys cinctus.
Glareola grallaria.

3.—(*a.*) Migrants from Eastern Asia through Malay Archipelago to Australia :—

Gallinago australis.[a]
Limosa uropygialis.
Limosa melanuroides.
Totanus incanus.
Tringa acuminata.[b]
Tringa crassirostris.[b]
Tringa ruficollis.
Numenius cyanopus.
Numenius minor.
Eudromias asiaticus.
Hæmatopus longirostris.
Charadrius fulvus.
Ægialitis geoffroyi.[c]
Ægialitis mongolica.[c]

(*b.*) Migrants from Europe and Asia, straying westwards to America :—

Terekia cinerea.
Totanus glottis.
Tringoides hypoleucos.
Tringa subarquata.
Ægialitis hiaticula.

(*c.*) Migrants in both America and Asia, but from the latter region to Australia :—

Tringa canutus.
Strepsilas interpres.
Squatarola helvetica.

The following species is an European and Asiatic migrant, which does not stray to America :—

Totanus stagnatilis.

The following is an American form straggling rarely into Europe, and has reached Australia :—

Bartramia longicauda.

The remaining species might be termed an Austro-Malayan resident, wandering northwards into the Indian region (Andamans)—(*Esacus magnirostris*).

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[a] Doubtfully recorded from island of Palawan.
[b] Recorded outside above limits as a wanderer westwards to India.
[c] Migrates westwards as far as east coast of Africa.

A glance at the above synopsis shews that our most resident species are the Sandplovers, Plover Stilts, and Oyster Catchers. Our Eastern Asiatic migrants are nearly all Sandpipers (*Scolopacidæ*), which is also true of the Palæarctic migrants; and the greatest wanderers are two of the Sandpipers and a Plover.

CORRIGENDA.

Page 261, at end, *add* 15.—Quaternions as a Practical Instrument of Physical Research. By A. M'Aulay, M.A.

Page 298, line 4 from top, *for* iron from Vesuvius, *read* iron ore from Vesuvius.

Page 298, line 10 from top, *for* magnetic particles ·06, *read* magnetic particles ·6.

Page 298, line 30 from top, *for* Wallerawang, like the preceding, also, from irregular deposits, *read* Wallerawang, from irregular deposits.

Page 298, line 36 from top, *for* about quarter across, *read* about quarter inch across.

Page 300, line 26 from top, *for* or ·14 per cent., *read* or ·69 per cent.

Page 303, line 18 from top, *for* statements which are of so many years standing, *read* (statements which are of many years standing).

Page 305, line 7 from top, *for* (by the bichromate volumetive process, *read* (by the bichromate volumetric process).

Page 311, line 41 from top, *for* added to thin solution, &c., *read* added to their solutions, &c.

Page 316, line 3 from top, *for* by the oxidation of silicate, *read* by the oxidation of silicide.

Page 316, line 24 from top, *for* Æthiops (Martialis Lemeryi), *read* Æthiops Martialis Lemeryi.

Page 319, line 13 from top, *for* It had the following, *read* it had the following.

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1890-91 Gould, Joseph, Christchurch, N.Z.
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1891-92 Grant, Mrs. C. H., Hobart, T.
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„ Greenwood, John, Corner Hotel, Castlemaine, V.
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1888-89 Griffith, Sir Samuel, K.C.M.G., Q.C., Brisbane, Q.
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„ Hales, C. Shirley, Hobart, T.
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1888-89 Leeper, Alexander, M.A., LL.D., Trinity College, University, Melbourne, V.
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„ Legge, Colonel W. V., Fingal, T.
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1890-91 Le Souef, Dudley, Royal Park, Melbourne, V.
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„ Lewis, N. E., Hon., Hobart, T.
„ Lewis, Rev. Julius, S. Jude's, Carlton, V.
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1888-89 Lilley, Sir Charles, Kt., C.J., Brisbane, Q.
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1888-89 Lindon, E. B., Albert-street, Brisbane, Q.
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1890-91 Login, Miss Louisa, Adelaide, S.A.
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1890-91 M'Laurin, Hon. Dr., Sydney, N.S.W.
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" Montgomery, A., Launceston, T.
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1891-92 Morrison, Dr. G., Geelong, V.
1888-89 Morton, Alex., F.L.S., The Museum, Hobart, T.
1890-91 Morton, H. B., Custom-street, E., Auckland, N.Z.
1888-89 Morton, H. G., Numba, Shoalhaven, N.S.W.
1890-91 Moseley, Montague, Christchurch, N.Z.
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1888-89 Mullens, Josiah, 92, Pitt-street, Sydney, N.S.W.
" Munday, John, Herberton, Q.
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1889 Murray, Reginald A. F., F.G.S., Mines Department, Melbourne, V.
1890-91 Murray, J. A. J., B.M. & M.S., High-street, Kaiapoi, Canterbury, N.Z.
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" Nesbit, Lionel L., Adelaide, S.A.
" Nevill, S. T., Right Rev., Bishop of Dunedin, Dunedin, N.Z.
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1889 Newbigin, Edward, Stella, Hunt Road, Prahran, V.
1888-89 Newman, H. W., Mainhead, Lucknow, via Orange, N.S.W.
1891-92 Norman, H. E. Sir H., Brisbane, Q.
1891-92 North, A., Launceston, T.
1888-89 Norton, Albert, Speaker's Room, Brisbane, Q.
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1891-92 O'Callaghan, Rev. Father, Zeehan, Tasmania.
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" Officer, G. W., Toorak, V.
" Officer, Mrs. J. H., Toorak, V.
" Ogburn, J., Charlton, V.
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1891-92 Ogilvy, A. J., Richmond, Tasmania.
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„ Piper, Miss K., Hobart, T.
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1890-91 Rosales, Mrs. A., Alta-Mira, Grandview Grove, Armadale, V.
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„ Walch, Mrs. Hobart, T.
„ Walch, C. E., Hobart, T.
„ Walch, A., Hobart, T.
„ Walker, E. H., Hobart, T.
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